SATELLITE TELEVISION

An educational booklet from **SPACE** Pacific Limited and its members throughout the Pacific

ALL YOU REALLY NEED TO KNOW
(BUT DIDN'T KNOW WHO TO ASK!)

NZ/A $10

EXPERIENCE

Our greatest asset, Your guarantee of a job well done.

When you are selecting your home satellite system look through your local dealer to find the experience that backs him or her up. If your dealer has selected
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these are the benefits that pass through to you.

Telsat Communications Ltd has served the needs of the Pacific satellite enthusiast since 1988; New Zealand's oldest and most established distributor of quality satellite reception products including:

CHAPARRAL COMMUNICATIONS — Inventors of the satellite dish Polarotor feed system that quickly became the standard of an industry world-wide, and a leading designer and supplier of high quality home satellite LNBs and Feed Horns.

ORBITRON — America's number one designer and manufacturer of home satellite antennas up to 7.3 metres in size and the leading antenna supplier world-wide.

DRAKE — Designers of specialised high tech communications equipment since 1943 and a leading supplier of home and commercial satellite receivers since 1981.

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PACE — Europe's leading designer/manufacturer of home satellite receivers selected by Rupert Murdoch's STARnet (Asia) to create the world's first all digital DTH TV system for the new AsiaSat 2 satellite and Australia's Galaxy DTH service.

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And that's experience you can count on.

PLUS – The Pacific's leading programme suppliers! Agents and representatives for ABN (Asia Business News), CMT (Country Music Television), and other fine programmers.

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SATELLITE TELEVISION:
ALL YOU REALLY NEED TO KNOW

(but - didn't know who to ask!)

Arthur C. Clarke (left) Sri Lanka, 1975

IN THE BEGINNING:
There Was Arthur C. Clarke

Satellite-direct television looks and sounds just like regular television. Only better. Technically, satellite-direct reception makes one 'minor' change in television transmission which differentiates it from 'regular' TV.

Way back in 1945, as World War Two was winding down in Europe, a young (26 year) Englishman named Arthur C. Clarke published a four page article in a relatively obscure English journal called *Wireless World*. Just prior to WW2, a number of nations (England, France, Germany and US) had developed experimental TV broadcast systems. Because of technical constraints, each system had limited coverage, reaching distances of 100km or less from the transmitter. Clarke's 1945 paper supposed a technical quandry.

"A recent study has shown that a network of stations and relays required to cover a small country such as Britain will be very costly; and covering an entire continent would be out of the question. When attempting to link continents transoceanic relays of the nature utilised for undersea telephone cables are clearly beyond our immediate technology and the cost would be outrageous."

Clarke's remarkable solution suggested that rather than constructing 600 TV transmitters for Britain alone, that a mere 3 be created. He calculated that each would reach 42% of the earth's surface area and that between the trio of "stations" the entire earth would be bathed in television programmes. At the time, Clarke had no interest in studying how many "regular" TV transmitters might be replaced by his trio of transmitters over the whole of the earth; he believed that replacing the 600 planned for England with a single device of his own design was significantly impressive. A decade later an American University group would calculate that Clarke's 3 "special" TV transmitters had the ability to replace nearly 90,000 "regular" TV transmitters on earth.

"On earth" is a clue to how Clarke's unique solution would work. He knew that TV transmissions were limited by terrain and distance; hills and mountains blocked service, and trying to receive a signal "beyond its line of sight coverage" (typically over a distance of less than 100 kilometres) was erratic at best. Clarke said, *"By placing each extraterrestrial relay station at an altitude of 36,000 kilometres and by positioning it directly over the*

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SPACE Pacific

Satellite
Programme
Access
Committ**E**e

SPACE Pacific Limited is a New Zealand company formed to function as a trade association for people who own satellite dishes, install and service satellite systems, and produce equipment and programming for home and commercial viewing. At the time of this publication, SPACE Pacific has members in 23 countries spread throughout the Pacific Ocean Region (POR).

SPACE was formed to 'lobby' satellite operators and satellite programme distributors to make their programming available to privately owned satellite-direct (dish) receiving systems. Strangely, perhaps, many programmers initially had no business plan to offer their programming to individual dish owners, preferring to deal only with national TV networks (such as Galaxy in Australia and Sky in New Zealand). After less than one year of existence, SPACE has been successful in convincing more than a dozen satellite programmers to be "sensitive" to the needs of rural and island-isolated residents of the Pacific. This means that you can now purchase a satellite dish for your home, lodge, campsite or business comfortable that the programming you have today will continue into the future, and be available at reasonable charge to you.

Membership in SPACE Pacific is open to four classes of enthusiasts - users - participants in the satellite direct industry. We invite your query to SPACE Pacific, PO Box 30, Mangonui, Far North, New Zealand (fax 64-9-406-1083).

SPACE Pacific conducts an annual South Pacific Region Satellite & Cable Show; next show dates January 23-27, 1996 in Auckland, NZ.

equator, 42% of the earth will receive its signals."

Initially, satellite relay was seen as a way of reducing time and dollar expenditures to create national and international television broadcast systems. Ultimately it would become much more.

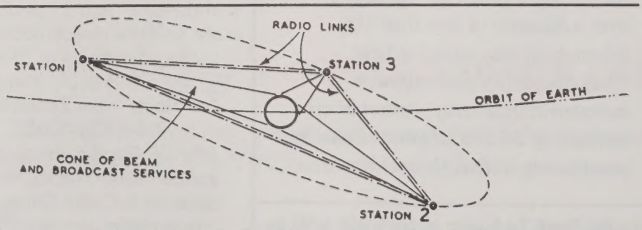
SLIGHTLY AHEAD OF REALITY:
First We Need The Rockets

Clarke, later to become primarily known as a science fiction writer, understood perfectly that in 1945 even the most powerful (German V2) rockets were woefully under powered for the task he outlined. However, with a meticulous concern for every detail of his "rocket launched radio relay stations" he carefully explained to readers each of the technical parameters of the fanciful system. So accurate was his engineering that 15 years later American and European scientists would turn to this 1945 technical paper as a foundation blueprint for the first generation (Syncom) satellites. And today, on the eve of the 50th anniversary of the publication of Clarke's plan, the Wireless World article still describes almost perfectly the satellites and the systems which today have unified the world into a single real-time communications 'grid'.

Between 1945 and 1960, reality caught up with theory. Transistors replaced valves (tubes), powerful multistage rockets with the thrust necessary to break free of planet Earth's gravitational field upgraded primitive German 'V-Bombs', and the first palm-sized calculating computers appeared. All of this technology 'fused' into Clarke's postulation and the communications satellite was born.

Clarke hypothecated a trio of satellites positioned at key locations: One at 30 degrees east would, Clarke suggested, service Africa and Europe; a second at 150 east would transmit to Asia and the Pacific, while a third at 90 degrees west would broadcast to the Americas. In the mindset of a native of Great Britain, Clarke saw no need for more than one satellite nor more than one TV 'channel' at each location. Clarke would later admit, *" It never occurred to me that people would want a choice of television programmes; after the BBC, could there actually be something else worth watching?"*

Fifty years following Arthur C. Clarke's article that introduced the world to the synchronous satellite concept, there are 174 operating satellites providing 1,392 separate channels of television programming around the world. As he had suggested, approximately 80% of these satellites and channels cluster near Clarke's 30 east and 90 west locations; Europe, Africa, and the Americas. The BBC is on satellite, as Clarke knew it would be, but with as many as four rather than a single programme channel. Even the BBC now admits people prefer programming choice.



Clarke's original vision - 3 satellites to serve the entire world

A MATTER OF SIZE:
Not In My Backyard!

Early satellites operated with feeble amounts of transmission power, comparable to the hand held two-way radios police use today. But the distances between satellite and TV watcher are great; 40,000 kilometres on average. As a point of comparison, the distances around the earth (the circumference) is (not coincidentally) 40,074 kilometres. Clearly, with so little transmission power, the satellite's signals would arrive on Earth very weakly.

Originally, gigantic antennas on earth were required; from 18 to 30 metres in diameter! Setting aside the cost of such a monster (well in excess of NZ/A$1,000,000 each), this was obviously not going to be something the average city dweller could (or would) ever fit into their back or side yard.

Like so many of our modern technologies, the first models were big, cumbersome and expensive (the earliest computers occupied more than 10 square metres of floor space, cost more than NZ/A$5,000,000 each and had the "computing power" of handheld calculators that now sell for less than $50). By the late 1970s, some 15 years after the first Clarke-orbit satellites were placed in space, antennas had been reduced to under 2 metres in diameter and the costs had fallen to below NZ/A$3,000. Progress.

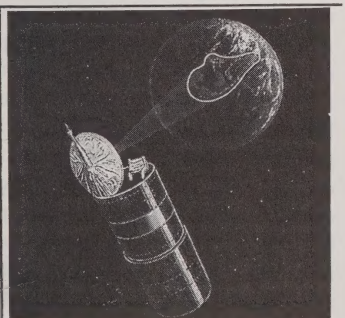
As the satellites grew more powerful the size of the "dish" antenna required by the ground stations shrunk in size. And with good reason: There is a one to one relationship between satellite transmission power and the size (and complexity) of the TV viewer's dish antenna system. Smaller dish antennas of course greatly reduced the cost of the dish itself; and, the necessary special satellite-direct receivers went through their own metamorphosis.

WHERE THE PEOPLE ARE:
If This Really Works ...

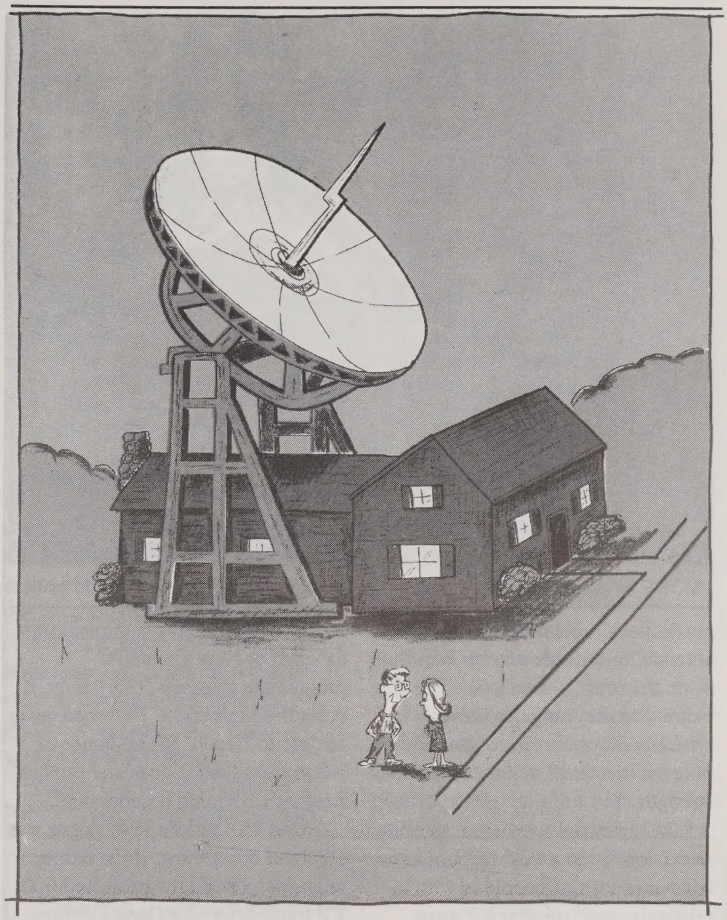
Satellite-direct television broadcasting differs only in technical form from the TV reception you are already acquainted with. Presently, you probably have an outdoor antenna mounted on your roof, a wire that connects the antenna to your receiver, and indoors one or more TV sets and one or more VCRs. And if you are an "average" television home in New Zealand / Australia, your television receiver is turned on around 3.5 hours per day (your home also rents an average of 1.3 "videos" each week).

For the present, the only significant difference between "terrestrial television" and "satellite-direct" television is programme choice; you will always have access to more programme channels (and therefore more programmes) with a satellite-direct system than you will from your terrestrial programme sources. But, as we shall see, in the near future satellite TV will mean far more to your home than simply having more programme choices.

A satellite-direct system consists of **(a)** a special antenna (called a 'dish' because of its unique circular or parabolic shape), **(b)** a purpose designed unit that installs at the antenna (called an LNB; we'll explain what it means shortly), and, **(c)** inside your home on top of your regular TV set, the satellite receiver.



In reality, the Earth is encircled by satellites - hundreds in all!



"Bob, I Still Think It Would Have Been Cheaper To Get The Cable."

Early monster dishes attracted barbs from cartoonists

The dish antenna is far more important to satellite reception than a rooftop antenna is for terrestrial reception. That's because the dish is a "power multiplier" capable of capturing those (still very) weak, distant transmissions from the Clarke-Orbit satellite and enhancing the signals to a level strong enough to operate your "system electronics" (that's the LNB and the indoor receiver portion). Over time, as more powerful satellites have developed, dish size has shrunk. But there are practical limits at work here and in the very best case those limits occur with dish sizes between 50 and 90cm in diameter. For most of us, the more desirable satellites carrying the most popular programme channels will require dish sizes of 1.5 to 3 metres for the foreseeable future (i.e., through 2000). As a practical matter, if the satellite services that interest you can be received with dish sizes of 1.5 metres or smaller, the dish can be attached ("mounted," in the trade)

MORE to reality - 1995 - 3 metre dish being installed for Auckland family

much like a normal terrestrial TV antenna; to the side of your building or on the roof. Dishes in the 2 to 3 metre diameter range, however, typically require a clothesline-like pole set in a small concrete base for strength.

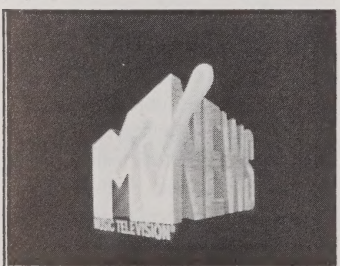
Like terrestrial television, satellite television "economics" favours large concentrations of people in relatively small geographic areas. An illustration:

Melbourne (Australia) has approximately the same population as all of New Zealand combined. For each TV programme channel to serve Melbourne there is one TV transmitter. To reach the same population in New Zealand requires approximately 450 TV transmitters for each of New Zealand's programme channels. Obviously, it costs the Melbourne TV broadcaster far less to "reach" his audience of 3.2 million than it does any of New Zealand's national broadcasters.

Arthur C. Clarke's 1945 paper was all about costs; how, if the money required to build the projected 600 TV transmitters for Great Britain was placed towards building a single satellite transmitter, they would achieve the same result. And, in the process as a bonus, send television to all of Europe and Africa at no additional cost!

Arthur's message did not go unnoticed. When the 1945 problems associated with developing powerful launch vehicles (rockets) and replacing burnt out valves (tubes) were sorted out by the 1960s, the science of satellites rapidly became the business of satellites. The first attention centred on those regions of the world where one satellite "beam" (signal) could reach the largest number of possible viewers: North America, Europe and Japan.

The US and Canada were first to "launch" satellite broadcasting; from a modest start in 1979, by 1984 more than a million home dish systems per year were being sold and installed. Europe was quick to follow as did Japan. The rapid growth of the marketplace soon had a profound impact upon the electronics portion of the satellite-direct system.



"Want your MTV???" Now available in Mandarin and English on 2 satellites.

Business people who were privately funding satellites in the 1980s were understandably cautious about how their money was invested. They faced several key decisions:

- ► Should they build satellites exclusively for one "class" of user?
- ► Should their satellites try to cover entire continents (such as Africa), or should they concentrate the satellite's power on smaller areas such as western Europe?
- ► And, should the satellites be designed only for commercial telephone company class users, or might they be designed for the lower cost dish systems used by television broadcasters?

INTELSAT:
First In The Air

The "safe road" to follow, in the early days of satellites, was to design satellites for the big moneyed commercial class users. The telephone companies of the world seemed like a prospective market since satellites can relay telephone calls as effortlessly as they relay television programmes. And the telephone companies were very interested in any system that would save them money. A second "safe market" was the world's television broadcasters; they were quick to grasp the "saleability" of being connected for live news and sporting event coverage on a world-wide basis. And they typically had the money to afford the costs of using satellite relay.

Intelsat, today a 100-plus consortium of nations, was the result. By raising funds from each of

the "member countries" (New Zealand paid .66 of 1% of the total cost while Australia paid 2.59%) the first Intelsat satellites were created. The "built-in" customer base (the respective telephone firms and TV broadcasters in each member country) all but guaranteed the success. The concept worked so well that private entrepreneurial firms wanted a piece of the action; a plan that Intelsat (understandably) initially opposed. They, after all, had an international monopoly and through the "signatory countries" non-members who were not a part of the respective national telephone or television operations found it difficult (and expensive) to use the Intelsat system.

The first non-Intelsat satellites were accused of "skimming the cream"; that is, they appeared to be designed to cover those portions of the world where the largest volume of business existed. In North America, cable television systems all across the continent were hungry for new programming sources and within six months of announcing its first "cable TV satellite" RCA had sold out all of the "channels" available. Satellite TV relay never looked back; in fact, today, cable TV systems in North Americas have more than 300 (!) separate programme channels to choose from for their customers.

Europe was a natural second choice. Only here, where cable TV was not yet mature, the satellite operators had to go directly to the viewers rather than through cable firms. This meant the satellites for Europe had to be designed, from the start, to serve very small home style dish antennas. The satellite operators knew that if they could make the signal to the ground strong enough, and dish antennas could be small enough, their chances for financial success would be far better.

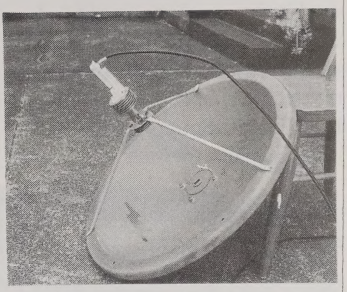
Did it work? Well, today there are more than a dozen satellites carrying in excess of 200 different programme channels to anyone in Europe who can find a spot on their balcony, roof or on the side of their home for a 50 - 90cm dish antenna. An estimated 15,000,000 homes in Europe have bought into the entertainment revolution inspired by Arthur C. Clarke and this rush to the new technology shows no sign of slowing down.

MEANWHILE:

In The Pacific

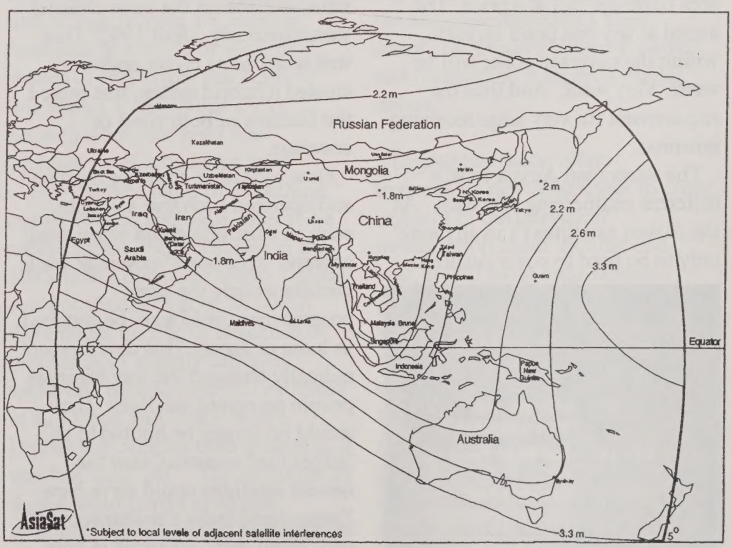
While some portions of the world were leaping onto the satellite relay bandwagon, the Pacific region was not totally dormant. Australia created a national satellite system (originally called Aussat; more recently Optus) in the mid-80s and Indonesia was quick off the mark with its own national satellite system in the early 80s. But something was missing.

People. The thinly populated Pacific Ocean Region simply had



When Australia's Optus or another Ku-band satellite begins serving New Zealand, this 65cm dish (functional, leaning against chair!) will do the job.

(and still has) too few people to attract the interest of the private satellite entrepreneurs. A satellite costs the same to build, launch and operate whether it serves 2.3 billion people (such as those that serve Asia) or 20 million (which is the sum of every nation south of the equator from Perth to Papeete). Even Intelsat could not show much enthusiasm for our "tiny market" and until 1994 the satellites they positioned to serve this region of the



SATELLITES - such as AsiaSat 2 - publish their coverage areas based upon the size of the antenna required to receive them. Here, 3 metre size dish is predicted for New Zealand area reached by this satellite, under 2 metre in parts of Australia; notice that virtually all of Asia is also reached.

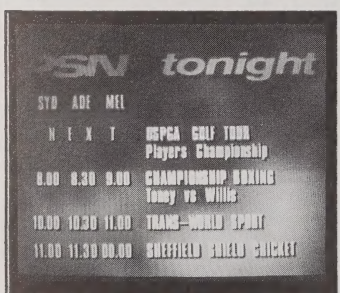
world were always "second hand Intelsats" having been previously used elsewhere and only brought to the Pacific after being first retired from Europe, South America, Africa, et al.

Then there was a breakthrough in satellite technology.

Intelsat satellites have typically been designed to transmit to (or cover) that 42% of the earth's surface which Arthur C. Clarke described in 1945. That's how much of the earth one could "see" if one was lifted by rocket to the height and position of a satellite. And because satellites employ radio frequencies known as "microwaves," they obey well known physical laws. One of those laws says that microwave beams only travel "line of sight"; in other words, they transmit from the satellite only to those points of earth that the satellite can "see."

This engineering approach to satellite "coverage" offers very wide area coverage, but at a price: The signal at any one point on earth, within the coverage zone, will be weak. Very weak. And thus the requirement for very large receiving antennas.

The Australian Aussat took a different engineering approach.. As the Aussat satellites (3 in all) were only to be used to cover Australia



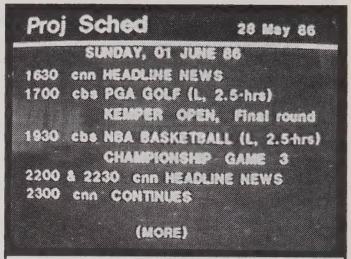
PREMIER Sports Network (on Optus) is typical of 24 hour sport channels offered.

proper (with an optional "side beam" to New Zealand), why waste power covering other portions of the globe? So they were designed to do just that: Cover only Australia. By doing this, the power that would have been wasted (by going to India, Japan and Hawaii) was focused on Australia. The result?

Now the Australian users of the satellite system would enjoy far stronger signals on the ground; signal that might have gone to India was now focused solely on Australia. And with stronger on-ground signals, smaller antennas could be used in Australia. Of course smaller antennas also meant lower cost ground terminals. It all made eloquent sense.

The technology breakthrough that changed all of this happened in this way. It was always known that you could have wide area coverage (they call it "Global" in the satellite business), or, you could have limited coverage (called "spot beam"). But you couldn't have both from the same satellite on the same channel simultaneously. Until 1992. That was when some clever engineers created a hybrid system that mixed the features of both types of coverage.

Now a satellite could be designed and operated such that a country such as Australia could enjoy small antenna "spot beam" coverage while simultaneously the same programmes could also be watched in India or Japan. This development radically changed the way business people perceived satellites. They would no longer be limited to an "either / or" scenario; now the newest satellites could serve New Zealand and India simultaneously, and "small dish" antennas in both countries (as well as all countries in between) could receive the same high quality images for a minimal outlay in home receive system hardware. Suddenly the small population base in the Pacific no



THE PAST: AFRTS was the first to reach New Zealand, Australia.

longer mattered. If the Pacific Ocean Region was too lightly populated to justify its own satellites, then with the newer satellites coverage to New Zealand, Australia and the islands of the Pacific could simply be "added on" to the main beams that would reach Asia's 2.3 billion residents. And from the satellite operator's point of view, the cost of adding the South Pacific coverage was minimal; just a few percent of the total cost of the satellite proper. They called it "bonus coverage."

IN THE PAST:

The Ugly Remnants Of Intelsat

New Zealanders and Australians have hardly endured this lack of satellite programme availability in silence. Nor have we lived in a vacuum, totally unaware of how satellites have transformed Europe, Asia, the Americas and Africa from isolated non-interconnected centres of population into the "Global Village." We have simply made the best of an ugly situation.

Intelsat service for the Pacific has been with us since the early 1980s. But because it was Intelsat and because the Intelsat satellites always generate global coverage (weak) signals, anyone who ventured into the satellite receiving world here had to be prepared to invest in a sizeable Intelsat-grade of antenna. Several hundred motels, private clubs, even some retirement centres did just this and the skeletal remains of dishes from 5 to 7 metres in diameter still dot our land and skyscapes as a

reminder of this not so long ago era. This was a period of time when although programmes on Intelsat were limited (first to the American AFRTS or armed forces TV service), they were at least "live" and the news and sports coverage available if not of high reception quality was at least more timely than the local terrestrial TV offerings. Within a few years, as a small cadre of private dish builders and installers were just beginning to enjoy a mini-boom for their products and services, two unfortunate things happened:

► The aged Intelsat satellite lost some of its transmission power causing some dishes to lose their pictures and all dishes to notice a significant degradation in reception;

► AFRTS "scrambled" (encrypted its programming, making it no longer available to private dish viewers).

At about the same time in New Zealand along came a private terrestrial network (Sky Network Limited) which offered in-home (in-club, in-motel) service from the USA at prices far below those required to purchase a private satellite dish system. As the Intelsat signals continued to grow weaker, interest in this form of "imported television" all but stopped in New Zealand although it continued in Australia where nothing like Sky Network had yet begun. A several year "dry spell" followed and the situation looked grim until the technological breakthrough that would add Pacific region coverage to the Asian satellites was announced.

OUR skeletal past: Huge 7 metre dishes on roof of Hamilton motel.

THE BIRTH OF DIGITAL:
All of the Rules Change

As often happens in life, one discovery in science begets another related discovery. In 1945, when Arthur C. Clarke was penning his thesis on space relays, television was less than a decade removed from the test tube. The first BBC telecasts to a published schedule had begun November 2, 1936. The first American scheduled (non-experimental) television did not begin until July 1, 1941. All television ceased, world-wide, until the end of World War Two hostilities.

The only kind of television Clarke and others knew in 1945 would later be called "analogue." That's a fancy electronic engineering term that describes the process by which the TV images travel from the studio or film or tape to your TV receiver. Analogue is a world of variations, shades of grey (from full white to full black). Even colour TV is nothing more (nor less) than adaptations of "shades of grey."

But the first seeds of something competitive to analogue, later to be called digital, were evolving in the 1945-infant computer world. Digital was not shades of grey, of which there might be tens or hundreds or thousands of slightly different variations between the two extremes of full black and totally white. Digital was simpler than analogue; it was "on" and "off." The evolution of digital would make analogue obsolete just as handheld calculators would forever banish slide rules, adding machines and Chinese abacus devices.

By 1990 digital had invaded the television world and a revolution was underway. Analogue had evolved; digital was no mere evolution, it has become a full blown revolution.

In an evolving world, it is possible to gradually improve products or services by making each succeeding generation work in a way so previous generations are not replaced but merely made obsolete. In a revolution such as digital, anything and everything based upon the analogue technology must simply be "trashed" (thrown away) and replaced by a superior digital device.

Digital television offers tremendous new advantages to every segment of the television transmission chain. For the end user, it will mean huge motion picture size images on flat screens with movie theatre size clarity and definition accompanied by 4, 6 or 8 sound tracks; all of the illusions of the cinema in your own home. For the broadcaster / programme creator, it will mean a new ability to transmit not merely a single camera view of a Rugby match, for example, but as many as 8 or 10 or 12 separate camera views simultaneously. This will allow the home viewer to individually select any viewing

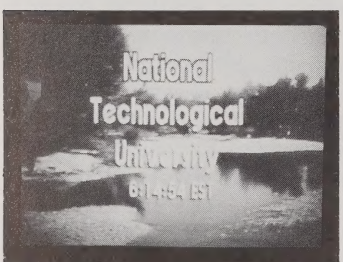
angle he or she wishes at will. With analogue TV techniques, the viewer was always stuck with the image selected for transmission by the programme producer. With digital TV, the broadcaster will select a "priority image" for viewers who didn't have the urge to "play director" but still allowing the viewer an option to make his own camera viewing angle decision.

But digital promised something far more important to the programme broadcaster as well: Economy.

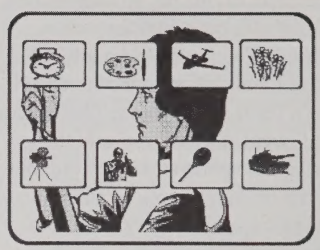
Digital is so much more efficient than analogue that now the TV programme creator can pack as many as ten separate programmes into the same "space" he now uses for a single analogue programme. Think of it this way.

► Presently, you turn the dial or enter a command on your TV set remote control to switch from TV1 to TV2 to TV3. Each of these programmes occupy a "space" or piece of the broadcast "spectrum."

► With digital, in the dial position now occupied by TV1, you will find as many as ten separate programmes, all different and all available to you at the touch of a remote control button. Your world just grew from 3 dial positions and 3 channels to 3 dial positions and 30 (programme) channels!



NTU / National Technology University offers schools, businesses, individuals diploma credit classes via satellite.



DIGITAL is efficient: 8 programmes in "space" of one analogue

Enter now the satellite programme entrepreneur. There are at least two different, unrelated companies, involved in transmitting programmes to you via satellite. The first is the company that builds, launches, and operates the satellite itself. Think of the satellite as an inter-city bus and there are 24 seats on board. When all 24 seats are occupied, the bus is full.

Then there is the programmer; firms with names like The Chinese Network, Country Music Television, The Discovery Channel and Asia Business News. These programmers create a TV programme schedule but they don't drive or operate the bus. They are merely bus "passengers." Each programmer rents space (or a seat on the bus) from the satellite operator.

Country Music Television can select a seat on bus 'A' or 'bus B' or 'bus C.' Each is a different satellite, and each satellite offers differing coverage and features. To attract customers to their "satellite bus" each satellite operator stays very competitive to have on his bus the latest in technology to give the programmer - rider the best possible service. If the bus has 24 "seats," there is room for 24 separate programme channels on that particular satellite.

Now bring on digital. Because digital format is so much more efficient than analogue, the satellite operator with 24 seats can urge his customers to use digital and "save money." This works because rather than occupying a full seat, a digital format programmer occupies between 1/6th and 1/10th of a seat. Now the "bus" can carry as many as 240 separate passengers (TV programme channels); up to 10 'passengers' in each seat (transponder). And, in fact, if the satellite is designed for this digital world, it can carry 240 programme channels for the same approximate cost to itself as 24 analogue programme channels.

Obviously, the programmers can now "buy a seat on the satellite bus" for approximately 1/6th to 1/10th the amount of money they used to spend for an "analogue seat." Not only do the established programmers save money (BIG money at that since analogue transponder 'seats' sell for fees upward of NZ$3,200,000 per year!) but the much lower costs of satellite "space" using digital now allows an entirely new "entry level" of programmers to go into business.

So you can see why everyone wants digital; it is better, it is cheaper, it is more flexible than analogue. You will be hearing more and more about digital this and digital that in the next few years; even your normal terrestrial TV (i.e., TV1, TV2 and TV3; ABC, SBS, 7, 9 and 10 in Australia) will convert to digital one of these days. And as a consumer, you will have the

opportunity to purchase digital Camcorders and digital home VCRs before the end of 1996. It is that close.

TOO MUCH AT ONCE?
The Age of Abundance

When television broadcasting arrived in New Zealand in 1960, only four areas initially had transmitters (Auckland, Wellington, Christchurch and Dunedin). Over the next decade television slowly expanded to cover the country, then a second channel was added and later colour arrived. Through this decade plus of initial development the only real choice the consumer had to make was "*Do I buy it now, or do I wait?*" Few waited.

The next era of evolution arrived when home style VCRs began to penetrate the marketplace in the mid 1980s, at about the same time as the first non-government owned and operated TV service began (TV3). Not long after this (1991) the first optional television began: the Sky Network "pay TV service." All of these services built upon the established analogue foundation and until colour arrived, a significant percentage of all New Zealand and Australian purchased TV receivers were built inside of the country, or final-assembled here. If the consumer had questions or concerns, they could be answered at the local (or national level).

But the introduction of Sky's pay television optional programming began a change in the way we think of television. For more than 200,000 New Zealand homes, Sky is an optional (paid for by the month) extra. Within Sky's coverage reach, 1 home in 5 has selected this optional extra service. There is a strong message here and executives at the established "free to air" networks (i.e., TV1, TV2 and TV3) are not blind to that message; more is better when it comes to choice of programming.

As the world's leading telecasting organisations have learned quite painfully during the past decade, mass appeal television programming can be dramatically attacked by programming which appeals to people with special interests. There are very few subjects which interest a majority of the people; almost none which interest every person. And given a choice between mass-appeal programming and "special interest programming," a percentage of the people will opt for something other than mass-appeal.

But the strength of the mass-appeal programmers has always been that they will attract more viewers at any given point in time than will a special interest programmer. And television exists because of its advertising revenue which in turn typically gravitates to the largest audience it can find at any given point in time.

Special interest programming, such as the Asia Business News channel available only on satellite, approaches its business plan not intending that it will survive (and eventually earn a profit) based exclusively upon its ability to sell advertising. It knows it cannot do this. Closer to home, Sky Network knew it could not exist on advertising alone and that is why it elected to charge viewers for access to its programmes, all of which must be classified as "special interest programming."

If you cannot sell enough advertising to provide a viable programming service, there are but two other options:

► Corporate support from one or more "sponsors" who see some value in your service being made available to the public at large, or,

► Charging viewers for the privilege of viewing.

In the world-wide family of satellite TV programming services, we find examples of each: Advertising supported television, corporate sponsored television, and, viewer supported. As a general rule the smaller the potential market (i.e., the smaller the "special interest family" of viewers), the more likely the service will survive by collecting a monthly or annual viewing fee.

SERVICE	# of Channels	Per Channel Per Month
Sky	4.5	NZ$11.94
Galaxy	9	A$5.55
TNT	1	US$4.17
CMT	1	US$4.17
ABN	1	NZ$8.33
CTN	1	US$20.00
MTV (*)	1	US$4.17

Satellite TV rates (shaded) are examples of those now being charged; all are paid on an annual basis. * / MTV Mandarin rate; English version is temporarily not available to individual homes.

A subscriber to the 4.5 channel Sky Network pays around NZ$52 per month. That works out to $1.73 per day for the service, or, $11.94 per month per channel. Similarly, an Australian home subscribing to the 9 channel Galaxy pay television service pays A$49.95 per month; $1.67 per day, or, $5.55 per channel per month. In the course of a year, each channel costs each home $138.60 in New Zealand and A$66.60 in Australia. Keep those numbers in mind.

EXPLAINING A HOME SYSTEM:
Adapted To The Pacific

A home satellite dish (satellite direct) receiving system for New Zealand, Australia or the Pacific Islands differs in many ways from those sold by the millions in Europe, the Americas and Asia. European dishes and some American

NOTABLE DIFFERENCES BETWEEN C and Ku BANDS

C-Band	Ku-Band
✓ Antenna Size: 1.8 to 3.7 metres	✓ Antenna Size: 60cm to 2 metres
✓ Cost: 1.1 to 2 times as expensive as Ku	✓ .9 to .5 of cost of C-band
✓ Susceptibility to signal fading during heavy rains: Slight	✓ Susceptibility to signal fading during heavy rain: Significant
✓ Mid-1995 / Number of satellites reaching New Zealand / eastern Australia: 9	✓ Mid-1995 / Number of satellites reaching New Zealand / eastern Australia: 7
✓ End-1996 / Number of satellites: 13	✓ End-1996 / Number of satellites: 8

dish systems are designed only for something called "Ku band" (to be explained shortly) and while they may be attractively priced their usefulness in the Pacific, today, is someplace between 0 and minus 1.

Some systems sold in Asia are adaptable to use in the Pacific, but only when the buyer understands the important differences that exist between the two regions. A bargain priced system sold in Hong Kong could well prove to be no bargain here when you discover it cannot receive several of our more desirable satellites without major (and expensive) modifications.

Until September of 1994, the only type of satellite-direct system you could install in the Pacific was for Intelsat; large dish, medium to low quality reception. After September, several new satellites went into operation and for the first time smaller dishes and satellite-direct systems have become available designed specifically for the type of Pacific service that will evolve over the coming two plus years.

There are two different satellite 'bands' in use. One is called C-band and the second Ku-band. Both deliver the same quality television, and if you walked into a room showing two pictures (one C-band and one Ku-band), you would have no clue which was which.

C-band satellites require larger receive antennas than Ku-band satellites. Ideally, we would only have Ku-band satellites because then all of the home dish antennas would be smaller (1.5 metres or less). This is not an ideal world; yet.

At the dish there is an electronics part called an LNB. A C-band LNB is physically larger than a Ku-band LNB but the costs are comparable.

Inside the home is the actual receiver. One receiver will work for both C and Ku, and that means you can in fact use one dish equipped with two LNBs (one for each 'band') and have selectable reception from either C or Ku. Based upon what you learn here, and elsewhere, you will decide whether you wish a C-band only, a Ku-band only or a "dual-band" system. Regardless of your choice, the receiver you purchase will function on both bands in the future if you wish to upgrade your system at a later date.

The receiver looks like almost every other kind of consumer electronics gadget; it may or may not have visible buttons, knobs, lights and perhaps even a meter face. As a rough rule of thumb, the more sophisticated the receiver, the fewer the number of knobs, switches and lights on the front face (visible to you in your home) of the receiver. The most sophisticated receivers communicate with you through their companion infrared remote control (just what you need; another remote control!). The least expensive still require to you touch them; turning knobs and pushing buttons to change channels and make other minor adjustments.

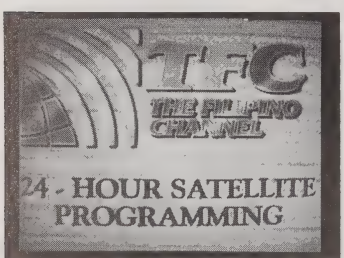
A "receiver" is more like a stereo FM tuner than a real receiver in the TV sense. While it is possible (mostly in Europe) to purchase a TV set that includes satellite tuning as a part of the features built into the receiver, most "satellite receivers" require your existing TV receiver to display the pictures and sound that you receive. In this sense, the "satellite receiver" is more of a tuner than a full "set."

The satellite receiver does several things that your TV set (or VCR) cannot do.

► It receives the special satellite format signals and "translates" them into something your standard TV receiver will recognise.

► It has the ability (if a more sophisticated receiver) to remember all of the receiver "settings" which are required for viewing any of the many programme channels you will be able to receive.

For the average home, a receiver with "memory" is important since this eliminates the channel by channel adjustments which lower cost receivers require. In the most elegant form, the full-memory receiver is as simple to operate as a



FILIPINO Channel includes 30% of average day in English with sports, movies, game shows. Cost is US$4.17 per month.

standard TV set: Simply remember which button to push for a particular programme channel, and the memorised instructions retained by the receiver will do the rest. The installer who puts in your satellite system will set up these memory circuits and unlike VCRs which still require complicated user 'button routines' this one will be a one-button, one-channel user friendly system.

► In addition to receiving television programmes, many receivers are also equipped to receive special satellite delivered radio (sound) services; such as the BBC World Service found 24 hours per day on satellite. Many of the sound-only services are available in full stereo with 'CD-quality' noisefree reception.

► In the not very distant future, satellite receivers will also be capable of being connected to a home computer (using RS-232 port standards) such that stock market reports, text news and even full computer software programmes will be delivered directly to your home via the satellite-direct connection. (Actually, these services already exist in Europe and North America and are promised for the Pacific and Asia as early as 1996.)

Anything you can receive on your satellite system can be recorded for later viewing or library filing. Unlike some video rental tapes which include a system to prevent duplication, satellite programmes do not presently limit your use (or reuse) in this fashion.

HOW MANY SATELLITES?

What Can I See???

In August 1994 the number of satellites that could be received with a typical 3 metre size dish in New Zealand was one. In August of 1995 that number has grown to 5. By August of 1996 that number will have grown to 9. However, the number of satellites is misleading as what really matters is the number of programme channels available to a home equipped with our "typical" 3 metre dish system. In the chart (right) satellites are identified by their name (i.e., PanAmSat) and their above-equator location (i.e., 169E); free to air is underlined.

In August of 1994: 5 programme channels, not all of them 24 hours per day. In August 1995: 23 programme channels, virtually all 24 hours. Looking ahead, by August 1996, the number of programme channels available will be in excess of 50. Not all of these channels are "free to air" (i.e., some are available only after agreeing to pay a subscription charge and equipping your home dish system with the required 'decoder' device).

Impressive? That is only the beginning. For this includes only those 'C-band' satellite channels, the ones that require the 2 to 3 metre

PRESENT & FUTURE (forecast) PROGRAMME CHANNELS

End of (year)	Ku Channels to NZ	Ku Channels to Australia	C Channels to NZ	C Channels to Australia
(19)95	7	20	53	40
(19)96	32	26	90	40
(19)97	46	58	106	110
(19)98	60	76	116	122

Australian numbers: C-band in most favoured portions of country (NT, QLD). Increases 1997 due to relaxation of ABA rules (see text).

SATELLITES/LOCATIONS

Intelsat 180: Older satellite, will be replaced with new 'bird' 1996. RFO, Worldnet, US networks, many fortuitous feeds. C + Ku capable.

Intelsat 177E & 174E: New satellites, largely used for telephone and data. Fortuitous TV feeds. C + Ku capable.

PanAmSat 169E: Presently largest carrier of cable TV & satellite-direct programming: CMT, CBS, ABN, CCTV, CTN, TSC, MTV, Discovery, CNNI, ESPN, Prime Sports, Showtime, Encore, NHK, CNBC, Filipino Channel, TNT + Cartoons, NTU et all. C + Ku capable.

Optus B1 160E: Australia's Ku only service with ABC, SBS and many fortuitous feeds. Not presently usable in most of New Zealand.

Optus B3 156E: Ku only with Galaxy Pay TV service, fortuitous feeds. Receivable in NZ but Galaxy will only accept Australian customers at this time.

Rimsat G2 142.5E: EMTV, ATN on C; Ku capable.

Apstar 1 138E: C only and only in NT, northern Queensland.

Rimsat G1 130E: RAJ throughout NZ, Australia; others in NT, Qld; C only.

JCSAT 3 128E: C + Ku capable, new, unknown programmers.

Palapa C2 118E: C only, scheduled May 1996. Up to 10 programmers.

Palapa C1 113E: C only, scheduled February 1996. HBO, ESPN, MTV, CFI, CNN, Gold, ATVI + 8 Asian TV networks.

AsiaSat 1 105.5E: C only, NT and Qld.; up to 10 channels

AsiaSat 2 100.5E (late 1995): BBC World, Prime Sports, Chan V, Star Plus, Zee, Chinese , Deutsche Welle in free to air; another 30+ in pay TV (subscription); all digital.

range dish sizes for home quality reception. Less certain is the future of the 'small dish' Ku-band services for the Pacific.

In attempting to reach the largest possible audience with their transmissions, the satellite broadcasters typically rely upon the satellite operator to offer them wide area coverage. Recalling the technology breakthrough in 1992 allowing satellite operators to achieve wide area coverage with one satellite, this is in fact only true with C-band transmissions. Most of the Ku-band transmissions from the present (and planned) satellites still are restricted to 'spot beam' (smaller area) coverage. This hurts thinly populated regions such as the southern Pacific because a Ku beam large enough to include all of the region south of the equator from Papeete to New Zealand could be deployed to point at Asia just as easily. In the case of the south Pacific, it might reach 4.5 million people; in the case of Asia, a billion plus.

Satellite operators are business people and they will, quite naturally, point their transmission beams where the largest audiences reside. This decision inhibits the immediate Ku-band growth possibilities for New Zealand and the surrounding region.

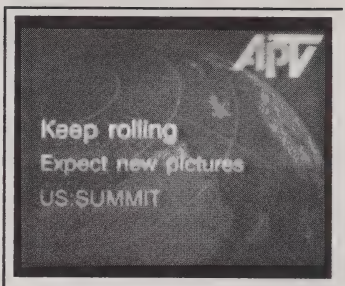
But all is not lost. In Australia, their latest Optus family of satellites have included into their design the ability to serve New Zealand along with their eastern coastal region. This means, at least in theory, New Zealanders could have access to and enjoy the same satellite programming available to residents of Sydney, Melbourne or Brisbane; using Ku-band antennas in the range of 1m diameter or less. That is "in theory" because at this point in time none of the programmers utilising the services of Optus have formulated a "marketing policy" with respect to New Zealanders and while it is technically possible to receive Australian pay television in New Zealand, the Optus programmers are not at the moment inclined to accept orders from here(!). As you will see in listings here, the Optus delivered Galaxy programme service presently consists of 9 programme channels at a cost of A$49.95 per month; or twice the programme choices as New Zealand's Sky Network at about the same price per month.

Ku-band service, as a result, to New Zealand remains something of an unknown. There are several satellites (see listing, page 11) with the capability to deliver high quality service to New Zealand but at the present time no programmer is making regular use of these capabilities.

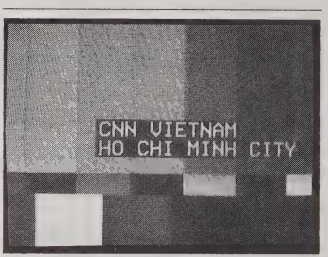
FORTUITOUS RECEPTION:
Just Like Fishing!

During the 1920s and 30s any family fortunate enough to own a home radio receiver quickly learned that by twirling the dial around a bit they might be treated to reception from unusual stations in far away cities; such as Los Angeles. There is a similar type of service available on satellite which attracts a keen following from people who enjoy being just a little bit ahead of their friends and neighbours with the latest in news and live sports coverage. This is the so-called "Feed Service."

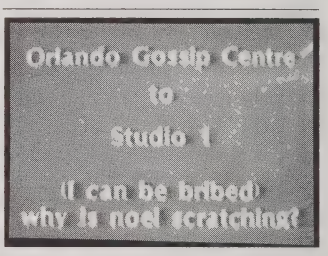
Virtually all television broadcast networks now rely upon satellite to bring in their news and sports programming when it originates outside of New Zealand or Australia. Additionally, many entertainment programmes are also delivered via satellite to networks. In both instances the programmes are videotaped at the Australian/ New Zealand networks and either



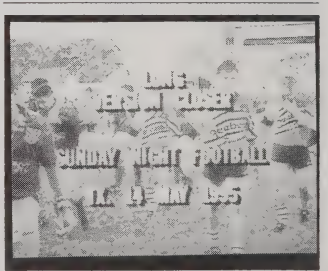
APTV (Associated Press) news feeds for TV stations world-wide. 'Raw feeds' before local TV manipulates them!



"Fly-Away" uplink taken by CNN to Hc Chi Minh City sent out 'raw, unedited' news feeds to the world's telecasters.



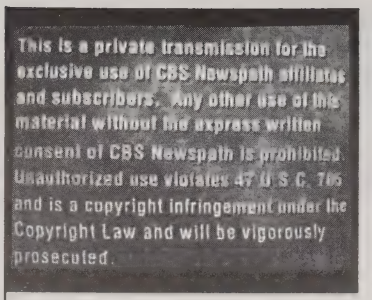
TV production personnel are human and 'fool around' during feeds. Here Chyron (graphics text) operator needles fellow employee unaware that half a world away somebody was watching!

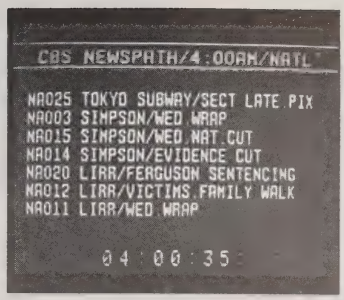


Satellite sports feeds are 'real' as it happens before networks 'clean' them up.

edited for later airing on their national services, or simply discarded when the content does not fit their own news, sports or entertainment format. Most of this programming is transmitted "in the clear"; that is, free to air. And when this happens, anyone with a home satellite dish can "tune in" and enjoy the content of the material. No laws, rules or regulations are broken (see "Copyright: Is It Legal?" here) if you watch these programmes in your home. You may even videotape the material if you wish without fear of legal problems, as long as you make no "commercial use" of this material (such as trying to sell it on tape to others).

Because the satellites have a wide reach, this "fortuitous reception" of sports, news and programming feeds is not limited to material being sent to New Zealand or Australian terrestrial broadcasters. In a typical day, you will "intercept" (i.e., find available for your own watching) literally dozens and dozens of feeds being transmitted via satellite to broadcasters throughout the Pacific and Asia. In a matter of 30 minutes you may find a live news feed from Australia to New Zealand, a sports feed from Japan to Singapore, the transmission of a preview showing of a US network programme to a broadcaster in Hong Kong and a segment of the BBC AM programme being transmitted to the Pacific. These "feeds" cluster on a couple of satellites and on specific transponders (channels). Thus unlike your grandparents who may have spent the evening twirling the dial looking for unusual programmes, you can simply set your satellite receiver on the channel normally used for feeds and wait to see what shows up, much like going fishing!


This is a private transmission for the exclusive use of CBS Newspath affiliates and subscribers. Any other use of this material without the express written consent of CBS Newspath is prohibited. Unauthorized use violates 47 U.S.C. 705 and is a copyright infringement under the Copyright Law and will be vigorously prosecuted.



Some transmissions have 'restricted use rights' but all may be watched privately in your home without breaking any laws.

COPYRIGHT:

So Much Fun: Is It Legal?

Can anything this entertaining, and contrary to the limited viewing fare of your neighbours, be legal? The answer is an unqualified yes.

New Zealand has a brand new Copyright act (effective 1 January 1995) and its very clearly spells out the "rights" of someone who owns a home satellite dish. They are:

a) You may "intercept and watch" any television programme found on satellite.

b) It is the responsibility of the programmer (i.e., the person or company placing the material on satellite) to clear any copyrights required. It is not the responsibility of the viewer.

c) If a programmer does not wish his programmes to be viewed by anyone who happens to own a satellite receiving system, the programme can be encrypted (scrambled). If a programme is scrambled, the programmer may then (if he wishes) offer viewing to the programme in exchange for a fee being paid.

There is nothing in our law that can force a programmer to offer you access to his programme, if scrambled. Whether he does, or not, is his choice.

And there are a few things you may (or should) not do:

a) You may record any material you see from satellite and share that programming provided it has not been clearly marked as "not for redistribution." A programmer who does not elect to scramble his transmission (i.e., he leaves it free to air) has the legal right to place an announcement at the beginning or within the transmission to advise you of his copyrights. This means you are not restricted from viewing the material, but you are not free to copy it and "share" the programming with others.

b) Programming sent specifically to New Zealand or Australian broadcasters, and somehow so identified by announcement, may not be taped for sharing with others even if you charge no fee for the shared use of the tape. You may still tape it for your own (family) use however.

In the case of scrambled programming for which you pay a fee (such as Country Music Television: CMT), when you 'order' the service for your home (motel, hotel) you will sign a contract which clearly sets forth the rights you have

Live coverage is hallmark of the satellite universe; here Asian CNBC business news channel.

by being a 'subscriber' to the service. Some of these contracts restrict you from making tapes for either shared use or resale to others. Under New Zealand law, however, even with subscription programming you cannot be prevented from making tapes for your own, private (family) use.

ACCESS:

By Subscription Services

Paying for television programming is not a new concept, dating back to at least the 1940s with Rediffusion in England. What is slightly new is that through the combination of computer technology and credit cards it is now possible for television programmers to send into your home programmes or programme channels which you can elect to 'buy' without even leaving home. In essence, you have (via satellite) access to a world-wide video store.

If you elect to purchase a home dish satellite-direct system there is no requirement that you also subscribe to even one 'pay TV service.' At the moment, approximately half of the services available are encrypted (scrambled) and you must pay a fee to access these channels. This is similar to purchasing a television set, placing an antenna outside, and sitting back to tune-in the local network services: Free, no viewing fee charged.

Once you have this initial system installed for your home, you then have the option of subscribing to one or more scrambled services. Again, this is very similar to your opting to subscribe to Sky Network service in New Zealand or Galaxy in Australia. Both Sky and Galaxy require payment of a monthly fee, and the installation to your existing television set of a 'decoder' device.

WHICH FORMAT for WHAT PROGRAMMERS?

Several similar but not identical "digital formats" are in the marketplace and each has its backers. At some future date either all programmers will use the same format, or (more likely) all receivers will work with all formats in use. In the second half of 1995, we must purchase receivers based upon the format of the programmer we wish to access. Subject to change, they are as follows:

Scientific Atlanta MPEG: ABN, CBS, CCTV, CMT, CTN, ABC-5 (Manila), TCS

General Instrument MPEG: Encore, Filipino Channel, Prime Sports, Showtime

NTL/(Pace) MPEG: Galaxy, Indovision, STARnet (on AsiaSat 2: 40 channels)

Philips MPEG: CNBC/Super Channel

Thomson MPEG: Canal Plus

Note: Not all programmers listed accept home-dish subscribers at this time.

Non-digital encrypted programmers continue but in time all will switch to digital (MPEG) encryption. The primary analogue encrypted programmers today, using B-MAC encryption are:

TNT + Cartoons, Discovery Asia, ESPN Asia, Australia ABC, Australia SBS, HBO Asia, MTV Mandarin.

But there is one not insignificant difference with satellite delivered subscription services; the actual decoder hardware.

There is a great deal of confusion concerning this decoder business. And here is why. Sky, the service, provides its own decoder and for all practical purposes they control the distribution of the decoders to the viewing public. The same is true with the Australian Galaxy service. However, ownership of the Galaxy decoder box will in no way benefit you if you wish to subscribe to the New Zealand Sky service; the two decoder boxes are totally different inside and are not compatible. A similar situation exists at the present time with satellite decoders.

There are five major coding technologies and each requires its own unique decoder box. A programmer such as CNBC, selecting the Philips (brand) coding system, requires that you purchase a Philips decoder to subscribe to CNBC. CMT (Country Music Television), meanwhile, requires a Scientific Atlanta (brand) decoder, The Filipino Channel requires a General Instrument decoder and so on.

AsiaSat 2's One-Stop / One Format Service Package

Rupert Murdoch's STARnet service (to be called digiSTAR on AsiaSat 2) offers a combination of no-viewing-charge (free to air or FTA) services plus optional pay TV add-on sports, movie and ethnic channels using a single new digital receiver. FTA will include: BBC World, Prime Sports, Star Plus (variety, sitcoms, game shows, documentaries), Channel V (an all music service), Zee TV (Hindi) and Chinese TV (Mandarin). As many as 40 optional pay channels will also be offered. This C-band service will reach all of Australia (2.4 metre dishes and smaller) but only portions of New Zealand (3 metre dishes).

Common sense (something the programmers may not presently possess) suggests that if they would all get together and share a common coding system the world would be a better place. Unfortunately, we are probably two to four years away from this common sense.

Today, this very day, when you decide to subscribe to a particular service, you must also acquire the required decoder unit. If you select two or more 'pay TV' services which happen to use the same decoder system, in most cases the single decoder will be usable for all services. But not in all cases and of course this makes subscription to a selection of pay TV services both complicated and frankly more expensive than it might otherwise be.

The near future will improve this not ideal situation:

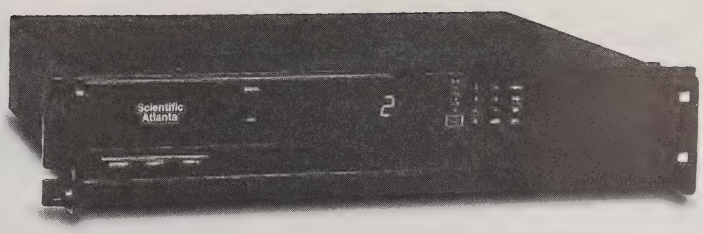
✓ A single receiver design, with the decoder portion built in, will (mid 1996) offer you the ability to subscribe to more than one coding format service. These receivers will be called 'DVB Compliant' and you may wish to file that term away for future reference.

✓ Programme packagers are coming; as soon as the end of 1995 - early 1996. One of these (to be discussed shortly) is STARnet, a service that is going to bring to many New Zealand homes (but not all; for Australia, see discussion on page 16) the ability to buy one receiver-decoder and then access the following:

► Five free to air channels with no programme charge (see STARnet data, page 14), plus,

► From a "menu" of as many as 40 additional services, one or more speciality programme services which will be encrypted but sent to your satellite system if you elect to subscribe to them.

So the present 'problem' which results from individual programmers each selecting their own (often unique to themselves) coding system is temporary. And a home dish system purchased today will in the worst case only be required to add to its original equipment a new 'DVB Compliant' or 'STARnet' type of receiver-decoder to gain access to the newer services. In the interim, before these services arrive, there is plenty of television available to you!



Present day digital service receiver, such as this Scientific Atlanta model D9222, is used by CTN, CMT, Asia Business News, others

WHAT DIGITAL MEANS:
A Library In Your Home

Back on page 7, here, we described the change now underway from the original analogue type of broadcasting format to something new called digital. As indicated, digital is an exceptionally efficient type of system and it offers so many benefits that in time all types of television delivery to your home will be digital. Even your television receivers will be replaced with digital receivers.

Because satellite delivery is a new system, it has been easier for satellite programmers to switch to digital from analogue than their terrestrial TV counterparts. Changing terrestrial TV to digital will require a wholesale change out of everything in the TV broadcast system: The TV cameras, the control room equipment, even the transmitters will be replaced. Sometime between 2000 and 2010, every TV set in New Zealand and Australia will either be replaced with digital receivers or people with analogue receivers will be required to purchase a "digital converter" unit to allow them to continue to use their old fashioned analogue TV sets with the new digital broadcasts.

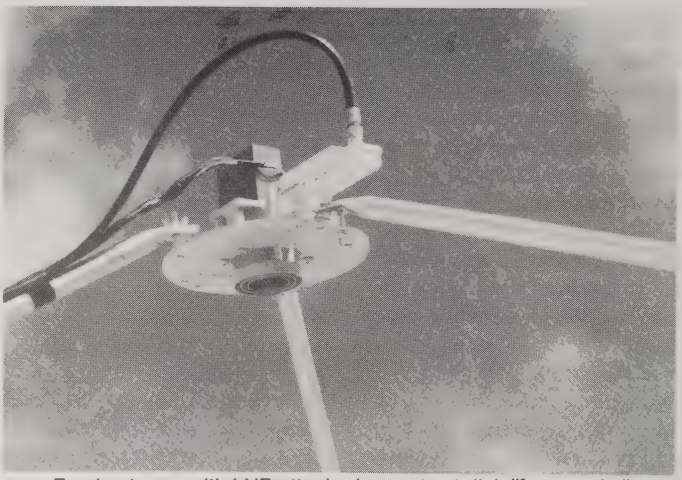
Satellite TV has a far smaller "receiver universe" in place, and in areas of the world where satellite TV is just now being established (such as the South Pacific), programmers have not hesitated to skip analogue totally and go directly to digital. Their reasoning is that if there are very few viewers in place to start off with, why not begin with a digital service and reap the benefits of digital from the beginning? Of course this means that as viewers do 'come on line' they will be purchasing digital satellite receivers rather than analogue satellite receivers.

(Note that your satellite dish, the LNB at the antenna and the cables between outside and inside care not whether the signal is analogue or digital. It is only the indoor receiver portion that is special for either analogue or digital. An investment in a dish, LNB and cables is not in danger of being outmoded by the approach of digital.)

GALAXY: Australia's direct to home (DTH) pay TV service

The first digital receivers to become available (in the middle of 1995) were offered for use to professionals; TV broadcasters, cable TV systems, for example. And they have been designed for this 'class' of user. In other words, they were not intended to be consumer friendly (consumer friendly: easy to use and adjust for a non-technical person). However, in mid-1995 they are the only digital receivers that you can purchase. Consumer friendly, designed for home use, digital receivers will not be available before late 1995.

Having said that, the digital format of transmission offers quite wondrous reception possibilities that were never previously available with analogue format systems. At the option of the programmer, images can be sent in standard screen or "wide screen" format. And your digital receiver will adjust automatically to the format. Also at programmer option, digital images can be high definition which means the detail on the picture is on a quality level with that you see in a modern cinema theatre regardless of the size of the image (up to and including giant 100" screens). Also at programmer option, two or more separate images of the same event can be transmitted with digital; imagine having the ability to select which camera 'shot' or which viewing angle you would like, using the remote control on your receiver during a Rugby Match, a concert or even a cooking programme. And in the sound department, full stereo is 'standard' while four channel sound and even 8 channel sound is available at the programmer's option. Gone forever will be the low fidelity sound creeping from the tiny speaker buried on the side of your TV set; replacing this will be the full theatre sound (to really have full measure of this feature will of course require that you place speakers throughout your TV room).



Feed antenna with LNB attached mounts at dish "focus point"

But all of this is "mechanical"; equipment with new, better functions. The real promise of digital is its ability to be a "Lending Library on Demand."

Digital is all about information storage and the rapid retrieval of that information by you on demand. The STARnet service, available by early in 1996, is an early example of what this is all about.

✓ You call a menu up on your TV screen and select a category with your remote control. Say it is "Nature":

► A sub-menu appears and now you "scroll" (push the arrow button) on your remote control and hundreds of films dealing with the many aspects of nature appear on the screen. You select a title with the arrow on the screen and push "enter".

► Within a few minutes the feature you have selected appears on your TV screen. There is a modest charge (perhaps $2) for this film being sent to your home, directly, via satellite.

This is the near term future headed your way through the satellite terminal you can purchase today.

AUSTRALIAN RESTRICTIONS:

Some Temporary Limits

Regulations of the Australian Broadcast Authority (ABA) make illegal private home subscription to many of the **pay** TV services in Australia before July 1, 1997. However, these rules do not prevent an Australian home from purchasing a home dish and accessing (watching) the free to air services now on satellite or available in the future. These rules are intended to allow Australia's Galaxy and cable TV service firms a head start before foreign originated programming is generally available. In remote areas of Queensland, the Northern Territory or Western Australia, the ABA regulations are today seldom enforced and many thousands of home dish owners in towns such as Katherine (NT) already enjoy non-Australian pay TV received from non-Australian satellites. Given the popularity of such programming in remote areas, it is unlikely the ABA will seriously challenge this activity since it plans to phase out these restrictions in 1997 anyhow.

BUYER CAUTIONS:

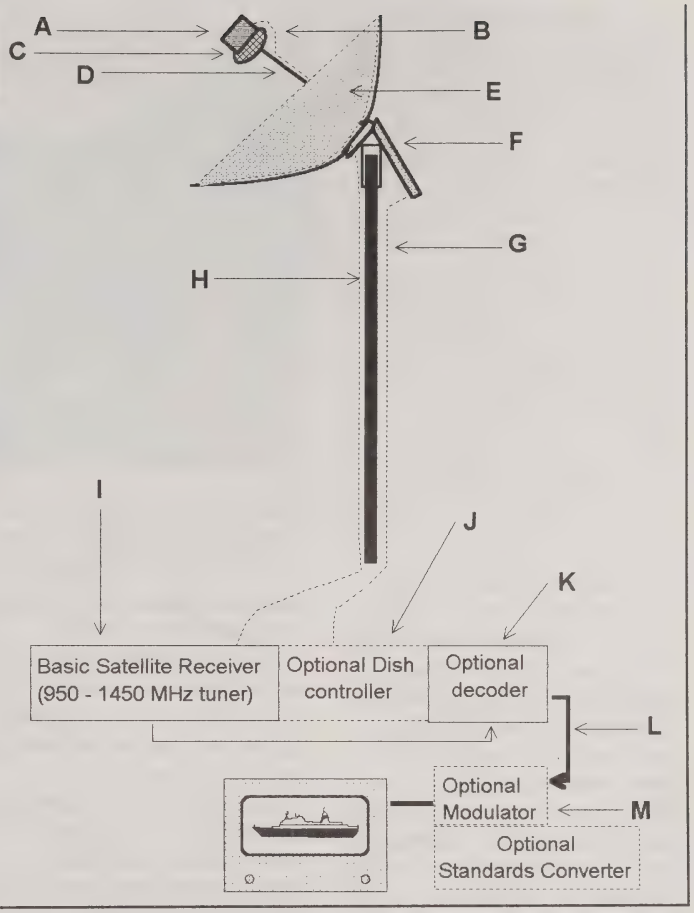
Watch Out For ...

First time buyers of satellite-direct home dish systems should be

ELEMENTS OF A HOME 'DTH' SYSTEM

For most 'DTH Viewers' the pieces that make up the system are primarily of concern to the installing dealer. However, should you be interested, they are as follows:

A - LNB (low noise block downconverter). Amplifies the weak satellite signals and sends on to the indoor receiver.
B - Coaxial cable, rated for satellite TV use, connecting LNB to indoor receiver. Also carries power to LNB from inside.
C - Feedhorn, the actual antenna that catches the energy intercepted by the parabolic dish and focused into the feedhorn funnel.
D - Feed support arm, holds feedhorn and LNB at dish focus point.
E - Dish (reflector) catches satellite signal and focuses to feedhorn.
F - (Optional) actuator motorised arm that points dish from satellite to satellite.
G - (Optional) actuator power cable.
H - Antenna support pole, typically 80mm diameter thick wall steel, in concrete.
I - Receiver and memory tuning unit to change and optimise reception for each channel.
J - (Optional) dish actuator power supply
K - (Optional) signal decoder for encrypted (pay TV) channels; may be built into receiver
L - Cable to TV set, VCR
M - (Optional) signal modulator and/or standards converter for NTSC signals



cautious and understand that the equipment is new to the Pacific so the experience level of installers may be limited. Separating what a system can do today from what it should be able to grow into doing tomorrow is important.

Here are some major points to understand:

The Dish:

The dish or antenna is usually sold based upon its size; larger dishes in theory have more "power gain" which means you will have better reception of the weaker channels (all channels are not created equal). However, there are caveats relating to dishes:

► Dishes with solid metal surfaces as a rule are better performing than dishes with screened-metal surfaces.

No, the holes in the screen metal surface does not degrade performance; at least not at C-band. The reason for the screen surface versus the solid metal surface is cost; it is less expensive to manufacture and ship a screen metal antenna.

► Dish parts (bolts, nuts, washers) will rust in our Pacific climate and if the dish is within range of a coastal sea-breeze, the salt content in the air will speed up this process. Most dish antennas are available with optional stainless steel parts. For a slight additional cost, stainless steel is recommended.

► A dish is a 'sail surface' in winds. Winds give the dish the 'jitters' (it moves about in the wind) and if it moves more than 15mm or so, the signal fades in and out as the dish 'flutters'. Larger dishes tend to move more than smaller dishes and some dish suppliers offer optional "wind stiffening kits" to dampen the dish movement in winds. If your area has frequent winds in excess of 50 km/h you should consider an antenna with a wind stiffening kit.

► A Ku-band dish will always work well on C-band but many C-band dishes will not work properly on Ku-band. Why?

1) Ku requires dishes that are structurally more precise, to a higher 'standard' than C-band. Dishes designed for C but "Ku adaptable" seldom give good performance on Ku. However, because Ku spot beams are very strong, this may not be an important factor.

2) Ku antenna pointing (the pointing of the antenna at the satellite) must be 3 times as precise as at C-band. This means that if the antenna moves in the wind, you will notice 'fading' of the signal at 1/3rd the antenna movement at Ku as at C. Therefore, 'rigidly mounted' antennas are more important at Ku than at C.

3) The 'holes' in the mesh surfaces on C-band dishes are allowed to be 3 times as large at C than at Ku before dish performance is degraded. A mesh surface dish should be "certified" to you as usable at Ku by the seller if you expect to be able to use it at Ku in the future.

The Feed:

This is a new term: feed. It describes a small secondary antenna which is installed at the front of the dish as a collection device (like a funnel collects water in an outdoor rain gauge). The satellite dish surface points at the satellite but no wires connect to the actual dish. Rather, the energy from the satellite, collected by the dish's (special) parabolic shaped surface, is focused to a single spot at the front of the dish. At this focus spot the feed is installed and it collects the signal reflected to it by the dish's curved parabolic surface.

The feed may or may not be a part of the LNB device. The purpose of the feed is to:

1) Collect signal from the dish

New Zealand broadcasts to Chatham, Pacific islands daily

Mesh antenna (C-band) panels slide into rib support structure to form parabolic reflector.

Actuator (tube assembly) has motor that pushes (or pulls) dish around central pivot point.

2) Separate for the receiver different sets of signals from the satellite (called polarisations). In the satellite world there are four possible 'polarisations' available: left hand circular (employed by the Rimsat family of satellites and some Intelsat satellites), right hand circular (Intelsat), and, linear horizontal plus linear vertical (used by virtually everyone else).

A feed designed only for linear (vertical and horizontal) will do a poor job receiving Intelsat or Rimsat and vice versa. While it is possible to purchase a feed that is only (left or right hand) circular, or only (horizontal or vertical) linear, if you intend to use your dish to watch a variety of satellites, you will require a feed that works with all four polarisations. On the other hand, if your dish system will only be used on (say) PanAmSat PAS-2 and you only wish to watch The Chinese Network, a simpler linear horizontal (only) feed can be installed.

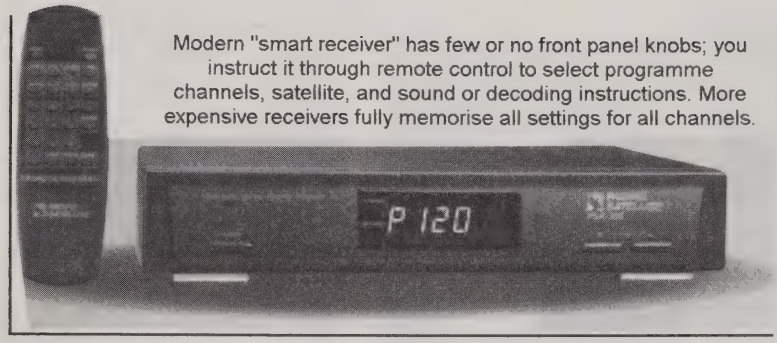
Just be aware that in selecting the proper feed, unless you select the model that receives all four polarisations, you are building into your system some natural limitations as to what the dish can be used to receive.

The LNB:

This is the electronic part that installs at the antenna, connected (bolted, actually) to the feed. The signals from the dish are collected by the feed and "funnelled" into the LNB where they are amplified (made stronger) and then electronically treated (frequency converted) for the trip from the dish to the indoor receiver.

LNBs are sold by their sensitivity. This is similar to purchasing a car based upon how fast it will go. In the case of the LNB, less (not more) is better. They use a unique language to describe their sensitivity; "degrees Kelvin" (at C-band) and "dB noise figure" at Ku. At C-band, a (degrees Kelvin) noise temperature of 30 or lower is considered "state of the art" and there are marginal reception quality advantages between an LNB rated at '20 degrees K' and one rated at '30 degrees K'. There will also be a price premium for a lower noise temperature LNB.

At Ku band, noise is measured in "dB units" and state of the art is around (0).6 dB. Price differentials



Modern "smart receiver" has few or no front panel knobs; you instruct it through remote control to select programme channels, satellite, and sound or decoding instructions. More expensive receivers fully memorise all settings for all channels.

between a 0.6 and a 0.8 can be more dramatic for Ku LNBs than for C-band units.

Most C-band LNBs are compatible and interchangeable world-wide. This is not true for Ku-band where Europe (for example) uses LNBs of a different configuration (because their satellites operate on different frequencies from ours). Therefore an LNB intended for Europe (no matter how attractive the advertised price and features may be) could be a total waste of money if brought to the south Pacific.

The Motor:

If you elect a home dish system that will tune-in more than one satellite, then the dish must be equipped with a small motor device. This motor (called an actuator in the trade) connects onto the dish such that when the motor is turned on the dish actually pivots (moves) on the support pipe. It moves left (west) or right (east) from its last setting. If it has been properly installed, this movement will cause it to point first at one satellite, then at another.

The motor drive is a sealed unit (millions have been built and sold; the design is mature and they are dependable) operating on a low AC voltage that is safe under normal circumstances.

Not all dishes are designed to have a motor (actuator) attached to them. If you want a dish to move, select either **(a)** a polar mounted dish, or, **(b)** a horizon to horizon dish. If you are likely to ever add a motor so as to be able to tune in multiple satellites, be certain your dish is designed for a motor.

The Wires:

Interconnecting the LNB (and motor) with the indoor receiver are wires. The wires carry a low operating voltage from the receiver to the outdoor equipment, and in the return direction on the same wires, either the satellite TV signals or the control signals of the motor or feed antenna system.

Wires may be directly buried in the ground (using a slit spade) if they are designed for direct burial (caution: not all wires are so designed), installed in a small diameter PVC conduit (or even flexible irrigation pipe), or run above ground. If the wires are directly buried and the ground is rocky, conduit should be used rather than direct burial as sharp stones can cut into the wires and markedly shorten their lifetime.

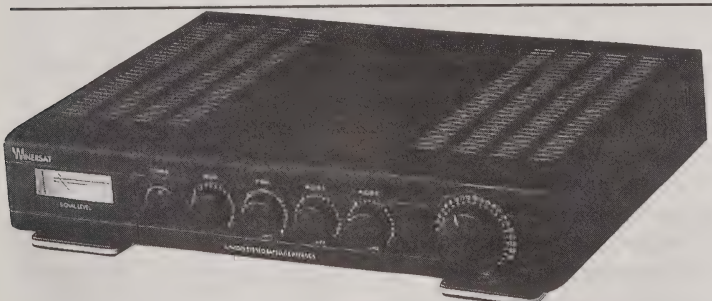
Moisture, getting into the wires through a nick or cut, can be a major problem. Likewise, sharp bends in the cable are to be avoided. Any bend that is tighter than you would have if you wrapped the cable(s) around your wrist is a mistake.

All connections between the outdoor ends of the cable and the equipment should be weather (moisture) protected. Some installers use a rubber "boot" which fits snugly over the connections to keep water out; others wrap the connections with an electrical outdoor rated tape. Still others use a silicone sealing compound over the top of all fittings (a compound that cures after application into a hardened watertight barrier). You can tell when your connections were properly weather sealed: After a rain, if your reception degrades, that is probably a sign that moisture has crept into something. If the reception gradually returns to normal as things dry out, you have a moisture related fault.

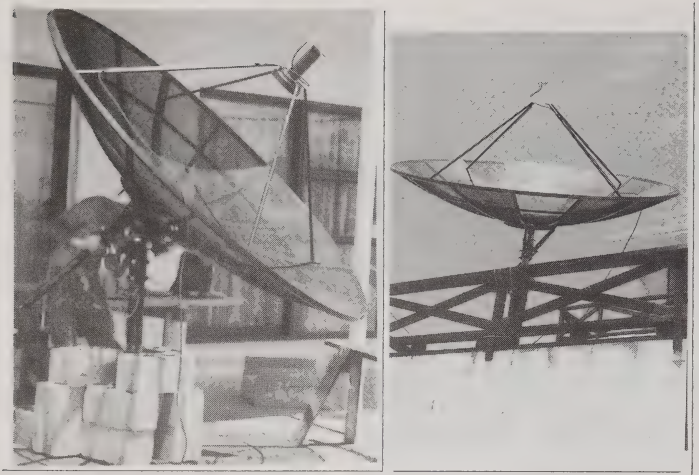
The Receiver:

Analogue-only receivers are the least expensive. There are no combination analogue and digital receivers available to consumers at this time (although there are some pricey professional models) but we do have digital only models.

Consumer style receivers do more than simply receive and process the satellite pictures and sound to your TV receiver(s). Optionally, they also:



Manual (knob) operated receiver requires hands-on touch.



This 2.4 metre dish was installed for testing under balcony overhang with blocks to support; later moved to balcony railing permanently

1) Control through the wires and the actuator which satellite your dish points towards;

2) Control, through the wires and the feed at the antenna, which polarisation your dish works at;

3) Adjust your receiver for the best picture and best sound on each satellite programme channel.

The least expensive receivers do this with manual (hands on knobs) controls. The more expensive receivers have built in memory circuits and once the optimised parameters for each programme channel have been 'entered' into the receiver (usually done by your installer) you do nothing more than push a button on your remote control to change "channels"; the receiver does the rest automatically to the memorised instructions.

The hand-on-knob version, the least expensive, is recommended for people who are not uncomfortable with or intimidated by consumer VCR programming. The everything-is-memorised (more expensive) models are for those who find anything more complex than a TV remote control intimidating. If your family is extensive and a variety of age groups will be using the system and changing channels, the everything-is-memorised version is recommended. Yes, it will cost more initially but the pleasure will be in the faultless performance and the programmes; you will not be distracted by people who cannot remember "*which way to move the dish to tune in EM TV*!" The first receiver you purchase will most probably be an analogue model and even if you wish to add digital reception abilities at a future date, there will continue to be many fine analogue services on Intelsat and Rimsat (at a minimum) for many years to come.

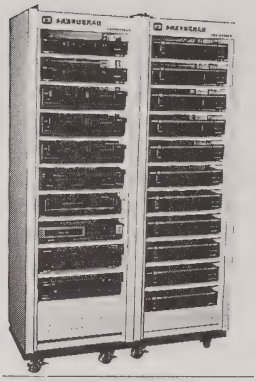
Digital receivers today are required (not optional) for many of the subscription services. A list appears on page 14. There is no reason why you cannot have two (or more) satellite receivers connected to the same antenna; one analogue, one digital. Your installer can wire it up so that you can select between the two. Digital receivers are known in the trade as IRDs which stands for **i**ntegrated **r**eceiver **d**ecoder. That means that what you are really buying is a completely new (digital) receiver with a decoder built-in.

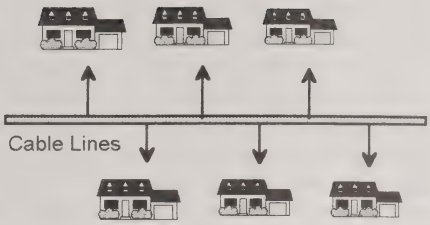
Recall that digital receivers presently available have been designed for the professional or commercial user: TV broadcast stations, CATV (cable TV) systems. These users have different needs than the average consumer. For one thing, the commercial user seldom (if ever) "changes channels" with his receiver. If he is tuned in to Asia Business News, he leaves the receiver tuned to that one channel 24 hours per day. This may suit your application (such as having Asia Business News on TV sets in a stock brokerage office), or it may not. If you plan to change channels with your 'IRD' there are some warnings:

✓Because the commercial receivers were not intended for frequent channel changing, they may not 'lock up' (properly decode) on the changed-to channel for as much as a minute or two after channel changing. Note that when consumer version digital (IRDs) are available, this problem will not exist.

✓IRD units may not be capable of controlling your feed adjustments or the motor actuator on your dish. A digital only system that requires feed adjustments (via the wire line control described previously) or dish moving will have to employ a separate "dish controller" box that will be an optional extra beyond the IRD unit. Or you can purchase an analogue receiver with all of these adjustments built-in.

Additionally, the professional quality digital IRDs are by analogue standards expensive receivers, even if they do combine the dual functions of a receiver and a decoder. Most users of the IRDs to date have been either semi-commercial (such as Chinese restaurants subscribing to The Chinese Network) or commercial (such as hotels adding Asia Business News for their business travellers). Still, if the expense of a commercial IRD does not turn you off, there is good value there for





Neighbourhood-wide system starts from seed-point user such as motel and uses coaxial cable to reach homes

viewers who have a special interest that is satisfied only by the programming available in the digital format.

Standards Conversion:

The world, unfortunately has never standardised on a universal television system . The North American and Japanese system, called NTSC, and the all-European / African system (called PAL), require different picture and sound reproduction circuits. A TV set for PAL, taken to America, will produce gibberish on the screen and howls in the sound. Likewise, an American programme brought to New Zealand in NTSC produces equally unintelligible gibberish. The answer is a standards converter.

Some TV receivers and VCRs now sold in New Zealand are equipped to play both PAL and NTSC standard signals. For those that are not, a small box known as a standards converter is added to the home system between the satellite TV receiver and the TV set (VCR). With this box, an American format (NTSC) picture goes in ... and a PAL format picture plus sound comes out. In this way your PAL standard TV set displays the picture just as if it had originated at the local TV transmitter. And your VCR records the satellite signal like it would any other PAL format signal.

SHARED SATELLITE DISHES:

Can one satellite dish be shared by two or more separate TV receivers? The answer is yes.

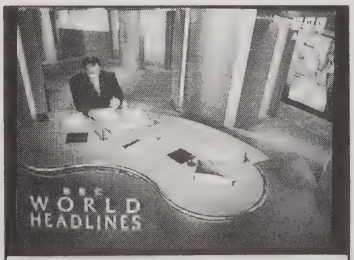
There are three different approaches to this:

1) There is one satellite TV receiver and therefore only one satellite TV programme channel can be watched at a time (the programme channel tuned in by the single receiver). However, your installer can quickly arrange for that one channel to be piped around your home just like regular TV reception and sent to any number of TV set "wall outlet jacks."

2) There are two or more different satellite receivers and each one is connected to a different TV set in the home. This becomes more complicated since each receiver may require connection to a different 'polarisation' at the feed antenna to select a desired programme. But there is hardware available to do this and your installer can create such a system. In this case each TV set has access through its own satellite receiver to any of the channels available from that one satellite.

3) Rather than placing a satellite receiver where each TV receiver is located, you place two or more separate satellite receivers in one location, and then connect the TV sets to these receivers through a master cable. In this scenario each TV set has full-time access to any of the satellite channels and any number of TV sets can be wired to the system. This is the principal used by cable TV systems and many motels have installed or plan to install what is known as SMATV (**S**atellite **M**aster **A**ntenna **T**elevision) systems to do just this.

Motels that wish to add any number of satellite-direct TV channels to their in-room TVs use this system and combine the satellite channels with the locally available terrestrial channels to create "8-10-12-ecetera TV channels here" systems for their clients. One motel in Hastings now offers 16 channels of TV to those who stay there. People actually go to this motel with VCRs in their baggage to videotape the all night movie, sports and music channels to take back home with them for later viewing! It sure beats handing out business cards.



BBC WORLD - full 24 hours per day on AsiaSat 2 satellite

4) Neighbourhood shared systems. A type of satellite redistribution system peculiar to New Zealand is called "Neighbourhood Cable TV." Here is how it works.

At one location one or more satellite dishes are installed. Each dish is capable of receiving full time reception from all of the programme channels from one satellite. By having two or more dishes this location can simultaneously access programmes from as many satellites as you have dishes.

By having full time access to more than one satellite, individual satellite receivers can be dedicated to receiving a single programme channel. Each of the satellite receivers processes (decoding where necessary) one programme source (channel) 24 hours per day. The individual receivers are then connected together such that they are combined onto a single coaxial cable. Now, all that remains is for that cable to 'run around the neighbourhood' stopping at each house along the way. In this system, through one coaxial cable and by using cable TV technology, a neighbourhood area can have 10, 20, even 30 separate TV channels full time. Inside each home individual TV sets function as if they were the only set connected to the system. The viewers can switch from channel to channel as they wish without concern about what other TV sets connected to the system may be watching. Each TV set has fully independent access to every channel carried by the system.

In theory, a group in a neighbourhood could pool their resources to install such a system. In practice this is usually undertaken as a business; one person or company puts up the money to build the system and by charging monthly subscription fees hopes to recoup the investment as well as a profit.

A seed point for such a neighbourhood system might be a local motel. If the motel is already subscribing to the Sky services for its rooms, it is paying $25.80 per room per month on average for access to the Sky channels. By replacing the 5 Sky channels with ten or more satellite channels, the motel might recoup the costs of the satellite equipment in as little as 24 months. If the motel then extends its service lines beyond its own facility, "into the neighbourhood," it could "sell" the cable TV service it originally created for its motel as a replacement for Sky. Such a system with as few as 50 "outside subscribers" could pay for the satellite equipment (and miniature cable system) in as little as 12 months. Of course once the initial investment has been recouped, the motel earns income with its "Neighbourhood Cable TV System."

Lacking a motel as a seed point, the economics of building a neighbourhood system change. And each situation requires a detailed economic and technical feasibility study to determine how long it might take for the original investment to be returned.

'NAUGHTY' PROGRAMMING: *Royal or Baby Blue?*

Of the many dozens of possible 'special interest' programme channels now available, or likely to become available on satellite in the near term, nothing attracts as much controversy as 'adult rated films;' (perhaps) pornographic material.

Present New Zealand law invokes a "standard of community decency" criteria to individual films. A national board decides, lacking previous rulings by similar bodies elsewhere in the world, how a particular film will be rated. Movie theatres have learned to live with the classification system; video rental stores have adapted. And "underground adult video shops" have from time to time stepped over the line and been busted as a result.

New Zealand laws apply to New Zealand originated material. New Zealand copyright law expressly avoids dealing with television programming that appears on satellite and originates elsewhere; it assumes that each point of origination (called the "uplink point" in the trade) has its own laws and that each uplink programmer does not violate the laws at the point of origin.

The law is not nearly so clear when applied to films transmitted into New Zealand which might, because of the content, under normal distribution systems require approval or at least classification by the national authorities. A move to revisit that law is currently underway.

As a practical matter, no "blue movies" are presently available on satellite to New Zealand viewers; but they could appear within one year or less. If we assume that any service that programmes such films follows the same operational pattern employed elsewhere (Europe, North America), the following 'standards' would apply:

✓ All transmissions would be encrypted (scrambled) and access by a home with a standard receiver would not happen.

✓ The service would be sold as 'pay TV' and therefore each viewer would be a paid subscriber to the service. This 'contract' between viewer and programmer shifts the viewing of the service from accidental to an act between 'two consenting adults'.

In fact, a viewer would most likely be required to not only pay for the monthly service but also purchase a decoder or 'IRD' unit for reception; another act between 'two consenting adults'.

✓ The programmer, if the North American X-rated service industry is a guide, would be very unlikely to select films which are in fact X (or triple-X) rated for direct showing via satellite. Most of the so-called 'Adult-rated' services in Europe and North America are in fact operated primarily as a marketing tool to sell 'hard core material' to viewers. They do this by scheduling non-X-rated material for actual satellite transmission, and then advertise the harder core X material as a mail order item which viewers can order on videotape that is mailed to their homes. Most of the 'adult services' are less about actual on-screen titillation via satellite than marketing 'harder product' through satellite merchandising mail order.

For now the issue is a non-issue lacking the availability of such a service. That such a service will one day appear is almost assured.

Naughty or "blue movie channels" are but one minor aspect of the marketing forces that are driving satellite-direct home dish reception to the forefront throughout the world as the next major communications industry. Satellite TV reflects the image of society itself because it is an increasingly important tool of society. More than anything else, the direction of satellite-direct television has been towards ever expanding choices for programme and information selection from your own home. In its mature form (in North America satellite-direct dish owners have access to more than 550 different channels!) it is very much like an ever expanding library of printed material available for your browsing or rental. Few individuals would be inclined to check out and read each of 550 different books in the local library and equally few would find nothing of interest in a selection of 550 different titles.

Our perception of television as a pure tool of entertainment or diversion will change as the "library of video" offered via satellite grows from its present limited fare to digital material available on demand in the near future.

TOMORROW IS TODAY:

Welcome To The 21st Century

New technology of the past decade has been eagerly embraced by a sizeable percentage of New Zealanders. Our acquisition rate for VCRs and Cellular telephones places New Zealand in the top ten of the world on a per capita basis. The subscription rate for Sky's over-the-air pay television service is also amongst the highest in the world for such a service.

Our experience with satellite service to date has been a disaster. By attempting to receive signals from Intelsat satellites which were never designed to serve small home style dishes, and by being forced to view tired, old, Intelsats at that (those with declining performance), we have been left with a sour taste for the premise of satellites.

But all of that is now past. During the next several years the availability of additional satellites will literally fill our sky with a plethora of choices, most which we cannot even forecast at this time. Arthur C. Clarke recently told an interviewer:

"*When all of this started I had no idea where it was headed, how long it might take to get to wherever it was going, or how we might adapt once we arrived. But I must say that the ride so far has been superb; I am so glad that I lived long enough to witness it first hand.*"

Doctor Clarke is this year 76 years young and 1995 is the 50th anniversary of his initial vision for "extraterrestrial space relays." Welcome to the magic carpet ride of the 21st century!

WHAT ABOUT COSTS?

SPACE Pacific Installer/Dealer members represent the 'backbone' of this young industry in the Pacific Ocean Region. Each dealer makes his or her own decision as to sources for the various component parts that make up a satellite-direct home dish system. With quite intense competition at the hardware manufacturing level for 'dealer loyalty' a wide range of products with a variety of special features are available. This industry is now entering its third decade in the world and although it may be 'new' in the South Pacific, the hardware we find available to us is itself very much a mature technology. This means the costs are about as low as they are going to become (exception: Digital function receivers are still very new and consequently still very expensive as explained in the text) and it also means the reliability (failure rate) is excellent; at least as good or better than normal TV receivers and VCRs.

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VANUATU (Port Vila) ◆ Telsat Pacific (23407)

ADDITIONAL INFORMATION

Entry level reference reading material includes "*The World of Satellite TV*" by Mark Long and Jeffrey Keating; subtitled "*Satellites For Asia,*" possibly still available (now out of print) at some Dick Smith Electronics stores in New Zealand and Australia (price near A/NZ$50). A limited quantity (fewer than 100) of these books are available at (postage paid) A/NZ$30 from SPACE Pacific, PO Box 30, Mangonui, Far North, New Zealand. Another excellent reading source is "*Install, Aim & Repair Your Satellite TV System*" by Frank Baylin; available by mail order (A/NZ$25, shipping included; order B1005) from AV-COMM Pty. Ltd., PO Box 225, Balgowlah, NSW 2093, Australia.

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Satellite reception demonstration - sampling tapes of several subscription services are available from SPACE Pacific. Non-member prices for approximately 2 hours on VHS SP are: Country Music Television, Chinese Television Network, The Filipino Channel, The Japanese Channel and The Discovery Channel - NZ$20 each inside of New Zealand, **US**$20 or equivalent elsewhere from SPACE Pacific, PO Box 30, Mangonui, Far North, New Zealand (tel: 64-9-406-1282, Fax 64-9-406-1083).

REPRINTED AS A BONUS from WIRELESS WORLD OCTOBER 1945

EXTRA-TERRESTRIAL RELAYS

Can Rocket Stations Give World-wide Radio Coverage?

By ARTHUR C. CLARKE

ALTHOUGH it is possible, by a suitable choice of frequencies and routes, to provide telephony circuits between any two points or regions of the earth for a large part of the time, long-distance communication is greatly hampered by the peculiarities of the ionosphere, and there are even occasions when it may be impossible. A true broadcast service, giving constant field strength at all times over the whole globe would be invaluable, not to say indispensable, in a world society.

Unsatisfactory though the telephony and telegraph position is, that of television is far worse, since ionospheric transmission cannot be employed at all. The service area of a television station, even on a very good site, is only about a hundred miles across. To cover a small country such as Great Britain would require a network of transmitters, connected by coaxial lines, waveguides or VHF relay links. A recent theoretical study[1] has shown that such a system would require repeaters at intervals of fifty miles or less. A system of this kind could provide television coverage, at a very considerable cost, over the whole of a small country. It would be out of the question to provide a large continent with such a service, and only the main centres of population could be included in the network.

The problem is equally serious when an attempt is made to link television services in different parts of the globe. A relay chain several thousand miles long would cost millions, and transoceanic services would still be impossible. Similar considerations apply to the provision of wide-band frequency modulation and other services, such as high-speed facsimile which are by their nature restricted to the ultra-high-frequencies.

Many may consider the solution proposed in this discussion too far-fetched to be taken very seriously. Such an attitude is unreasonable, as everything envisaged here is a logical extension of developments in the last ten years—in particular the perfection of the long-range rocket of which V2 was the prototype. While this article was being written, it was announced that the Germans were considering a similar project, which they believed possible within fifty to a hundred years.

Before proceeding further, it is necessary to discuss briefly certain fundamental laws of rocket propulsion and "astronautics." A rocket which achieved a sufficiently great speed in flight outside the earth's atmosphere would never return. This "orbital" velocity is 8 km per sec. (5 miles per sec), and a rocket which attained it would become an artificial satellite, circling the world for ever with no expenditure of power—a second moon, in fact. The German transatlantic rocket A10 would have reached more than half this velocity.

It will be possible in a few more years to build radio controlled rockets which can be steered into such orbits beyond the limits of the atmosphere and left to broadcast scientific information back to the earth. A little later, manned rockets will be able to make similar flights with sufficient excess power to break the orbit and return to earth.

There are an infinite number of possible stable orbits, circular and elliptical, in which a rocket would remain if the initial conditions were correct. The velocity of 8 km/sec. applies only to the closest possible orbit, one just outside the atmosphere, and the period of revolution would be about 90 minutes. As the radius of the orbit increases the velocity decreases, since gravity is diminishing and less centrifugal force is needed to balance it. Fig. 1 shows this graphically. The moon, of course, is a particular case and would lie on the curves of Fig. 1 if they were produced. The proposed German space-stations would have a period of about four and a half hours.

It will be observed that one orbit, with a radius of 42,000 km, has a period of exactly 24 hours. A body in such an orbit, if its plane coincided with that of the

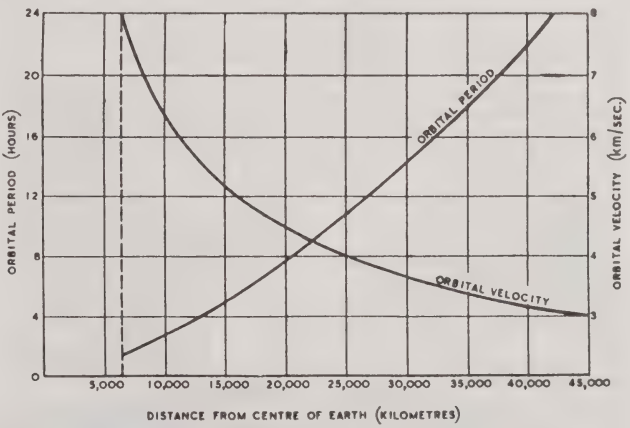

Fig. 1. Variation of orbital period and velocity with distance from the centre of the earth.

PERMISSION TO REPLICATE granted by ARTHUR C. CLARKE

Extra-terrestrial Relays—

earth's equator, would revolve with the earth and would thus be stationary above the same spot on the planet. It would remain fixed in the sky of a whole hemisphere and unlike all other heavenly bodies would neither rise nor set. A body in a smaller orbit would revolve more quickly than the earth and so would rise in the west, as indeed happens with the inner moon of Mars.

Using material ferried up by rockets, it would be possible to construct a "space-station" in such an orbit. The station could be provided with living quarters, laboratories and everything needed for the comfort of its crew, who would be relieved and provisioned by a regular rocket service. This project might be undertaken for purely scientific reasons as it would contribute enormously to our knowledge of astronomy, physics and meteorology. A good deal of literature has already been written on the subject.[2]

Although such an undertaking may seem fantastic, it requires for its fulfilment rockets only twice as fast as those already in the design stage. Since the gravitational stresses involved in the structure are negligible, only the very lightest materials would be necessary and the station could be as large as required.

Let us now suppose that such a station were built in this orbit. It could be provided with receiving and transmitting equipment (the problem of power will be discussed later) and could act as a repeater to relay transmissions between any two points on the hemisphere beneath, using any frequency which will penetrate the ionosphere. If directive arrays were used, the power requirements would be very small, as direct line of sight transmission would be used. There is the further important point that arrays on the earth, once set up, could remain fixed indefinitely.

Moreover, a transmission received from any point on the hemisphere could be broadcast to the whole of the visible face of the globe, and thus the requirements of all possible services would be met (Fig. 2).

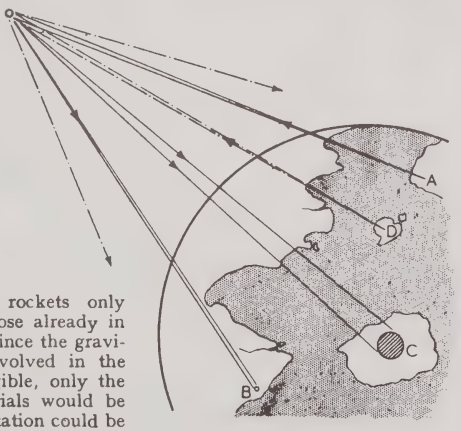

Fig. 2. Typical extra-terrestrial relay services. Transmission from A being relayed to point B and area C; transmission from D being relayed to whole hemisphere.

It may be argued that we have as yet no direct evidence of radio waves passing between the surface of the earth and outer space; all we can say with certainty is that the shorter wavelengths are not reflected back to the earth. Direct evidence of field strength above the earth's atmosphere could be obtained by V2 rocket technique, and it is to be hoped that someone will do something about this soon as there must be quite a surplus stock somewhere! Alternatively, given sufficient transmitting power, we might obtain the necessary evidence by exploring for echoes from the moon. In the meantime we have visual evidence that frequencies at the optical end of the spectrum pass through with little absorption except at certain frequencies at which resonance effects occur. Medium high frequencies go through the E layer twice to be reflected from the F layer and echoes have been received from meteors in or above the F layer. It seems fairly certain that frequencies from, say, 50 Mc/s to 100,000 Mc/s could be used without undue absorption in the atmosphere or the ionosphere.

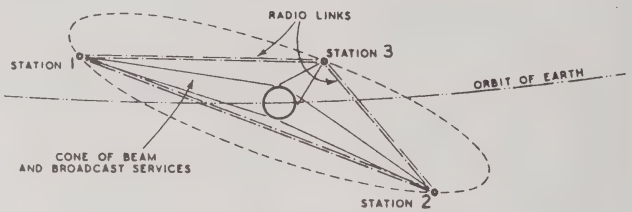

Fig. 3. Three satellite stations would ensure complete coverage of the globe.

A single station could only provide coverage to half the globe, and for a world service three would be required, though more could be readily utilised. Fig. 3 shows the simplest arrangement. The stations would be arranged approximately equidistantly around the earth, and the following longitudes appear to be suitable:—

30 E—Africa and Europe.
150 E—China and Oceana.
90 W—The Americas.

The stations in the chain would be linked by radio or optical beams, and thus any conceivable beam or broadcast service could be provided.

The technical problems involved in the design of such stations are extremely interesting,[3] but only a few can be gone into here. Batteries of parabolic reflectors would be provided, of apertures depending on the frequencies employed. Assuming the use of 3,000 Mc/s waves, mirrors about a metre across would beam almost all the power on to the earth. Larger reflectors could be used to illuminate single countries or regions for the more restricted services, with con-

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sequent economy of power. On the higher frequencies it is not difficult to produce beams less than a degree in width, and, as mentioned before, there would be no physical limitations on the size of the mirrors. (From the space station, the disc of the earth would be a little over 17 degrees across). The same mirrors could be used for many different transmissions if precautions were taken to avoid cross modulation.

It is clear from the nature of the system that the power needed will be much less than that required for any other arrangement, since all the energy radiated can be uniformly distributed over the service area, and none is wasted. An approximate estimate of the power required for the broadcast service from a single station can be made as follows:—

The field strength in the equatorial plane of a $\lambda/2$ dipole in free space at a distance of d metres is

$$e = 6.85 \frac{\sqrt{P}}{d} \text{ volts/metre, where}$$

P is the power radiated in watts.

Taking d as 42,000 km (effectively it would be less), we have $P = 37.6\ e^2$ watts. (e now in μV/metre.)

If we assume e to be 50 microvolts/metre, which is the F.C.C. standard for frequency modulation, P will be 94 kW. This is the power required for a single dipole, and not an array which would concentrate all the power on the earth. Such an array would have a gain over a simple dipole of about 80. The power required for the broadcast service would thus be about 1.2 kW.

Ridiculously small though it is, this figure is probably much too generous. Small parabolas about a foot in diameter would be used for receiving at the earth end and would give a very good signal/noise ratio. There would be very little interference, partly because of the frequency used and partly because the mirrors would be pointing towards the sky which could contain no other source of signal. A field strength of 10 microvolts/metre might well be ample, and this would require a transmitter output of only 50 watts.

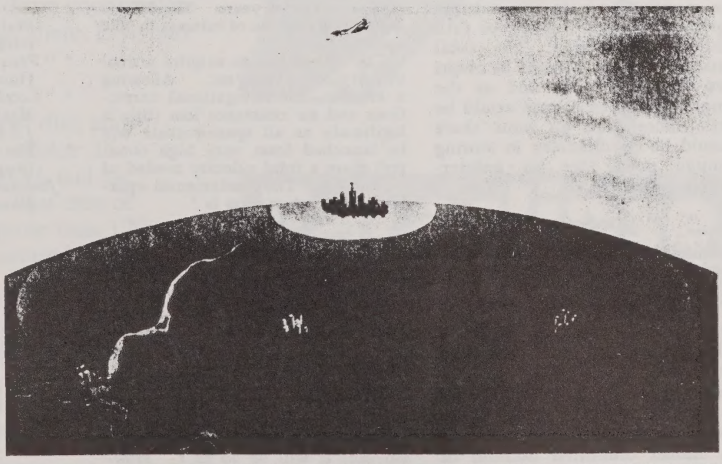
When it is remembered that these figures relate to the broadcast service, the efficiency of the system will be realised. The point-to-point beam transmissions might need powers of only 10 watts or so. These figures, of course, would need correction for ionospheric and atmospheric absorption, but that would be quite small over most of the band. The slight falling off in field strength due to this cause towards the edge of the service area could be readily corrected by a non-uniform radiator.

The efficiency of the system is strikingly revealed when we consider that the London Television service required about 3 kW average power for an area less than fifty miles in radius.[5]

A second fundamental problem is the provision of electrical energy to run the large number of transmitters required for the different services. In space beyond the atmosphere, a square metre normal to the solar radiation intercepts 1.35 kW of energy.[6] Solar engines have already been devised for terrestrial use and are an economic proposition in tropical countries. They employ mirrors to concentrate sunlight on the boiler of a low-pressure steam engine. Although this arrangement is not very efficient it could be made much more so in space where the operating components are in a vacuum, the radiation is intense and continuous, and the low-temperature end of the cycle could be not far from absolute zero. Thermo-electric and photo-electric developments may make it possible to utilise the solar energy more directly.

Though there is no limit to the size of the mirrors that could be built, one fifty metres in radius would intercept over 10,000 kW and at least a quarter of this energy should be available for use.

The station would be in continuous sunlight except for some weeks around the equinoxes, when it would enter the earth's shadow for a few minutes every day. Fig. 4 shows the state of affairs during the eclipse period. For



A project which goes part of the way towards the goal envisaged in this article has been put forward by Westinghouse in collaboration with the Glen L. Martin Co. of America. The radius of coverage would be increased from 50 to 211 miles by beamed radiation from an aircraft flying at a height of 30,000 ft. and equipped with television and FM transmitters.

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this calculation, it is legitimate to consider the earth as fixed and the sun as moving round it. The station would graze the earth's shadow at A, on the last day in February. Every day, as it made its diurnal revolution, it would cut more deeply into the shadow, undergoing its period of maximum eclipse on March 21st. on that day it would only be in darkness for 1 hour 9 minutes. From then onwards the period of eclipse would shorten, and after April 11th (B) the station would be in continuous sunlight again until the same thing happened six months later at the autumn equinox, between September 12th and October 14th. The total period of darkness would be about two days per year, and as the longest period of eclipse would be little more than an hour there should be no difficulty in storing enough power for an uninterrupted service.

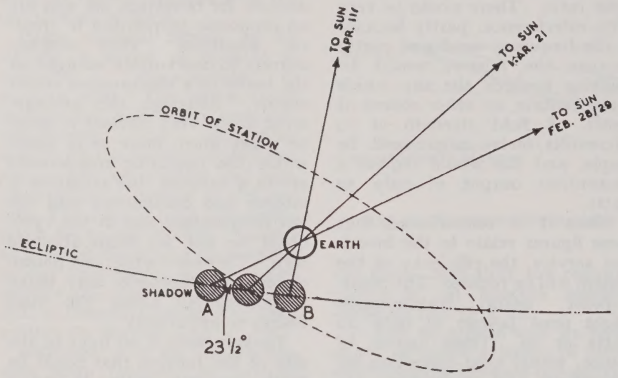

Fig. 4. Solar radiation would be cut off for a short period each day at the equinoxes.

Conclusion

Briefly summarised, the advantages of the space station are as follows:—

(1) It is the only way in which true world coverage can be achieved for all possible types of service.

(2) It permits unrestricted use of a band at least 100,000 Mc/s wide, and with the use of beams an almost unlimited number of channels would be available.

(3) The power requirements are extremely small since the efficiency of "illumination" will be almost 100 per cent. Moreover, the cost of the power would be very low.

(4) However great the initial expense, it would only be a fraction of that required for the world networks replaced, and the running costs would be incomparably less.

Appendix—*Rocket Design*

The development of rockets sufficiently powerful to reach "orbital" and even "escape" velocity is now only a matter of years. The following figures may be of interest in this connection.

The rocket has to acquire a final velocity of 8 km/sec. Allowing 2 km/sec. for navigational corrections and air resistance loss (this is legitimate as all space-rockets will be launched from very high country) gives a total velocity needed of 10 km/sec. The fundamental equation of rocket motion is [2]

$$V = v \log_e R$$

where V is the final velocity of the rocket, v the exhaust velocity and R the ratio of initial mass to final mass (payload plus structure). So far v has been about 2-2.5 km/sec for liquid fuel rockets but new designs and fuels will permit of considerably higher figures. (Oxy-hydrogen fuel has a theoretical exhaust velocity of 5.2 km/sec and more powerful combinations are known.) If we assume v to be 3.3 km/sec, R will be 20 to 1. However, owing to its finite acceleration, the rocket loses velocity as a result of gravitational retardation. If its acceleration (assumed constant) is a metres/sec.^{2}, then the necessary ratio R_g is increased to

$$R_g = R \frac{a + g}{a}$$

For an automatically controlled rocket a would be about $5g$ and so the necessary R would be 37 to 1. Such ratios cannot be realised with a single rocket but can be attained by "step-rockets"[3], while very much higher ratios (up to 1,000 to 1) can be achieved by the principle of "cellular construction"[3].

Epilogue—Atomic Power

The advent of atomic power has at one bound brought space travel half a century nearer. It seems unlikely that we will have to wait as much as twenty years before atomic-powered rockets are developed, and such rockets could reach even the remoter planets with a fantastically small fuel/mass ratio —only a few per cent. The equations developed in the appendix still hold, but v will be increased by a factor of about a thousand.

In view of these facts, it appears hardly worth while to expend much effort on the building of long-distance relay chains. Even the local networks which will soon be under construction may have a working life of only 20-30 years.

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[7] *Journal of the British Interplanetary Society*, Jan., 1939.

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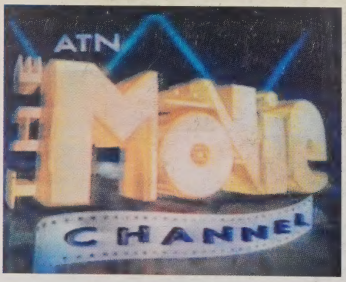

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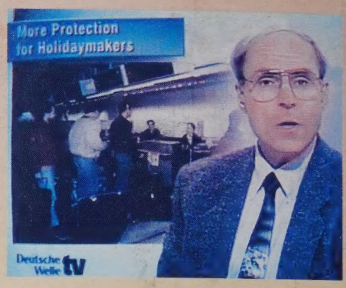

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